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(54) Apparatus and process for reagent fluid dispensing and printing.

(57) A system for printing and dispensing chemical reagents in precisely controlled volumes onto a medium at a precisely controlled location. A jetting tube, comprising an orifice at one end and a fluid receiving aperture at the other end, is concentrically mounted within a cylindrical piezo-electric transducer. The fluid receiving aperture is connected to a reservoir containing a selected reagent by means of a filter. The reservoir is pressurized by a regulated air supply. An electrical signal of short duration is applied to the transducer. The pulse causes the transducer and the volume defined by the jetting tube to expand, thereby drawing in a small quantity of reagent fluid. The cessation of the pulse causes the transducer and the volume of the jetting tube to de-expand, thereby causing at least a substantially uniformly sized droplet of reagent fluid to be propelled through the orifice. The droplet may be directed to impact a printing medium or collected in a dispensing recepticle.

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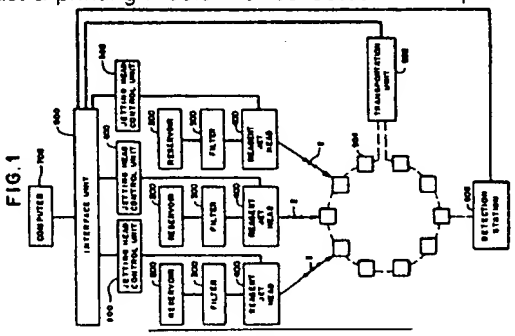

FIG. 1

APPARATUS AND PROCESS FOR REAGENT FLUID DISPENSING AND PRINTING

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus and process for dispensing and printing reagent fluids, wherein a transducer is used to propel small quantities of the fluid towards a positioned target.

Diagnostic assays often require systems for metering, dispensing and printing reagent fluids. In the case of metering and dispensing, such systems comprise both manual and automatic means. For purposes of practicality, the present background discussion will focus on the methods of metering and dispensing 100 micro-liter volumes or less.

The manual systems of metering and dispensing include the glass capillary pipet; the micro-pipet; the precision syringe; and weighing instruments. The glass capillary pipet is formed from a precision bore glass capillary tube. The pipet typically comprises a fire blown bulb and a tubular portion fire drawn to a fine point. Fluid is precisely metered by aspirating liquid through the tube into the bulb to a predetermined level indicated by an etched mark. The fluid may then be dispensed by blowing air through the tube.

The micro-pipet typically comprises a cylinder and a spring loaded piston. The travel of the piston is precisely determined by a threaded stop. The distance the piston travels within the cylinder and the diameter of the cylinder define a precise volume. The fluid is aspirated into and dispensed from the micro-pipet in precise quantities by movement of the piston within the cylinder.

The precision syringe generally comprises a precisely manufactured plunger and cylinder with accurately positioned metering marks. The fluid is introduced into and dispensed from the syringe by movement of the plunger between the marks.

Weighing techniques for dispensing fluids often simply involve weighing a quantity of fluid. The density of the fluid may then be used to determine the fluid volume.

Exemplary automatic metering and dispensing systems include the precision syringe pump; the peristaltic pump; and the high performance liquid chromatography (HPLC) metering valve. The precision syringe pump generally comprises a precision ground piston located within a precision bore cylinder. The piston is moved within the cylinder in precise increments by a stepping motor.

The peristaltic pump comprises an elastomeric tube which is sequentially pinched by a series of rollers. Often the tube is placed inside a semi-circular channel and the rollers mounted on the outer edge of a disc driven by a stepping motor. The movement of the rollers against the tubing produces peristaltic movement of the fluid.

The HPLC metering valve comprises a defined length of precision inner diameter tubing. The fluid is introduced into the define volume of the tubing with the valve in a first position and then dispensed from the tubing when the valve is placed in a second position.

All of the above metering and dispensing systems have the disadvantage that the volumes dispensed are relatively large. Furthermore, these systems are also relatively slow, inefficient and comprise precision fitted components which are particularly susceptible to wear.

The printing of reagent fluids is frequently required in the manufacture of chemical assay test strips. Selected reagents are printed in a desired configuration on strips of filter paper. The strips may then be used as a disposable diagnostic tool to determine the presence or absence of a variety of chemical components.

Generally, to perform a chemical assay with a test strip, the strip is exposed to a fluid or a series of fluids to be tested, such as blood, serum or urine. In some instances, the strip is rinsed and processed with additional reagents prior to being interpreted. The precise interpretation depends on the type of chemical reactions involved, but it may be as simple as visually inspecting the test strip for a particular color change.

The manufacture of test strips generally involves either a manufacturing process or a blotting process. The blotting process is the simplest manufacturing method and permits most reagents to be applied without modification. A disadvantage of this process is that it is difficult to blot the fluids onto the test strip with precision.

The printing process will often involve any of three well known methods: silk screening; gravure; and transfer printing. The silk screening of reagents generally involves producing a screen by photographic methods in the desired configuration for each reagent to be printed. The screen is exposed under light to a preselected pattern and then developed. The areas of the screen which are not exposed to light, when developed, become porous. However, the areas of the screen which have been exposed to light remain relatively nonporous. The screen is then secured in a frame and the test strip placed below. The desired

reagent fluid, specially prepared to have a high viscosity, is spread over the top side of the screen. The reagent passes through the porous areas of the screen and onto the test strip. The test strip is then subjected to a drying process, specific to each reagent. Once the test strip is dry, it may be printed again using a different screen, pattern and reagent.

The gravure method of printing reagents comprises coating a metal surface with a light sensitive polymer. The polymer is exposed to light in the desired predetermined pattern. When developed, the polymer creates hydrophilic and hydrophobic regions. The reagent is specially prepared such that when applied to the metal it will adhere only to the hydrophilic regions. After the specially prepared reagent is applied, the test strip is pressed against the metal and the reagent is transferred from the metal to the test strip.

The transfer printing method comprises transferring the reagents from a die to the test strip in the desired pattern. The die is made with the appropriate pattern on its surface and then coated with the desired, specially prepared reagent. A rubber stamp mechanism is pressed against the die to transfer the reagent in the desired pattern from the die to the rubber stamp. The rubber stamp is then pressed against the test strip to transfer the reagent, in the same pattern, to the test strip.

Each of the above-mentioned reagent printing techniques has significant disadvantages. The most common disadvantage is the requirement that the reagents must be specially prepared. Additionally, if a variety of reagents are to be printed onto a single test strip, the strip must be carefully aligned prior to each printing. This alignment procedure increases the cost and decreases the throughput of the printing process. Moreover, a special die or screen must be produced for each pattern to be printed. A further disadvantage arises in that the above printing methods are unable to place reproduceable minute quantities of reagent on the test strip.

It is an object of the present invention to provide a printing and dispensing method and apparatus which avoids these disadvantages.

SUMMARY OF THE PRESENT INVENTION

The present invention is directed to a reagent dispensing and printing apparatus and method, wherein the apparatus comprises a transducer operative to eject a substantially uniform quantity of reagent in a precise predetermined direction.

According to one preferred embodiment of the present invention used in dispensing reagent fluids, a jetting tube is concentrically located with a piezoelectric transducer. The jetting tube comprises an orifice at one end and a reagent receiving aperture at the other end. The receiving end of the jetting tube is connected to a filter which is in turn connected to a reservoir containing a selected reagent. A jetting control unit supplies an electrical pulse of short duration to the transducer in response to a command issued by a computer. The electrical pulse causes the volume defined by the jetting tube to expand by an amount sufficient to intake a small quantity of reagent fluid from the reservoir. At the end of the pulse duration, the transducer de-expands propelling a small quantity of the reagent fluid through the orifice and into a fluid recepticle. If desired, additional droplets may be deposited in the recepticle or the recepticle aligned with an additional jetting tube for receiving an additional reagent fluid.

An additional preferred embodiment of the present invention may be used for printing reagent fluids onto a print medium. In this embodiment, the jetting tube is aligned with the printing medium such that the propelled droplet impacts a precise position on the medium. The jetting tube or print medium may then be repositioned and another droplet expelled from the jetting tube. The process may be repeated until a desired configuration of the reagent fluid is printed on the medium.

One advantage of the present invention is that precise minute quantities of reagent fluid may be dispensed or printed in a reproducible manner. Additionally, the method and apparatus may be used to emit droplets of fluids having a wide range of reagent fluid viscosities and surface tensions. The reagents do not in general have to be specially adapted for use with the present invention.

The invention itself, together with further objects and attendant advantages, will best be understood by reference to the following detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic representation of a first preferred embodiment of the present invention showing the use of multiple jetting heads to meter and dispense reagent fluid.

FIGURE 2a is a perspective view of a first preferred embodiment of the jetting head of the present invention.

FIGURE 2b is a cut-away perspective view of the preferred embodiment of Fig. 2a taken along lines 2b-2b with the contact pins removed.

FIGURE 2c is a sectional representation of the preferred embodiment of Fig. 2a taken along lines 2c-2c.

FIGURE 2d is a sectional representation of the preferred embodiment of Fig. 2c taken along lines 2d-2d.

FIGURE 2e is a sectional representation of the jetting tube and transducer of the preferred embodiment of Fig. 2b taken along lines 2e-2e.

FIGURE 3 is a schematic representation of a second preferred embodiment operating in the drop on demand mode as a reagent printing system.

FIGURE 4 is a schematic representation of a third preferred embodiment operating in the continuous mode as a reagent printing system.

FIGURE 5a is a schematic representation of a portion of the jetting head control unit showing the LED strobe circuit.

FIGURE 5b is a schematic representation of a portion of the jetting head control unit showing the high voltage power supply circuit.

FIGURE 5c is a schematic representation of a portion of the jetting head control unit showing the print control circuit.

FIGURE 5d is a schematic representation of a portion of the jetting head control unit showing a portion of the print pulse generator.

FIGURE 5e is a schematic representation of a portion of the jetting head control unit showing an additional portion of the pulse generator.

FIGURE 6a is a perspective view of a second preferred embodiment of the jetting head of the present invention.

FIGURE 6b is an exploded view of the preferred embodiment of Fig. 6a.

FIGURE 7 is a sectional representation of a third preferred embodiment of the jetting head of the present invention.

FIGURE 8 is a sectional view of a symmetrical portion of a fourth preferred embodiment of the jetting head of the present invention.

FIGURE 9 is a graph of the drop mass of the emitted droplets as a function of emission frequency for several fluid viscosities.

FIGURE 10 is a graph of the velocity of the emitted droplets as a function of frequency for several fluid viscosities.

FIGURE 11 is a graph of the total weight of fluid emitted as a function of the number of emitted droplets for a given fluid.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

Turning now to the drawings, Fig. 1 shows a schematic representation of a first preferred embodiment of a reagent dispensing system generally represented as reference numeral 30. The dispensing system 30 comprises a plurality of reagent fluid reservoirs 200, a plurality of filters 300, a plurality of reagent jetting heads 400, a plurality of jetting head control units 500, an interface unit 600, a computer 700, transportation unit 902, a plurality of fluid mixing cells 904 and a detection station 906.

The reservoir 200 holds a selected quantity of reagent fluid for dispensing. The reservoir 200 is maintained at atmospheric pressure by suitable means such as an atmospheric vent. The reagent fluid is transferred from the reservoir 200 through the filter 300 to the reagent jetting head 400. The filter 300 is placed between the reservoir 200 and the jetting head 400 to ensure that any particular foreign matter in the reagent fluid is trapped before entering the jetting head 400.

The plurality of jetting heads 400 and the detection station 906 define a processing path. Each jetting head 400, which is described in detail below, ejects uniformly sized droplets 2 of reagent fluid. The droplets 2 are propelled, with controlled velocity and direction, towards a selecting mixing cell 904 positioned along

the processing path by the transportation unit 902. The mixing cells 904 are comprised of non-reactive material and function as minute holding tanks for the dispensed reagent fluid.

The plurality of jetting heads 400, shown in Fig. 1, are positioned sequentially along the processing path. Alternately, some or all of the plurality of jetting heads 400 may be positioned with respect to the transportation unit 902 such that the heads 400 direct the droplets 2 into a selected mixing cell 902 simultaneously.

The jetting heads 400 and the transportation unit 902 are controlled by the computer 700. The computer 700 issues commands to an interface unit 600 which is electrically connected to the transportation unit 902 and to the jetting head control unit 500. The interface unit 600 is of conventional design and is used to control the transfer of information between the computer 700 and the jetting control unit 500. The interface unit 600 is also used to control the transfer of information between the computer 700 and the transportation unit 902.

A first embodiment of the reagent jetting head is shown in Figs. 2a - 2e and generally represented by numeral 400. The jetting head 400 comprises a two piece symmetrical housing 402, 404. The housing 402, 404, when assembled, is adapted to form an orifice aperture 406, an air vent and reagent supply channel 410 and a transducer chamber 403, shown in Fig. 4b. Four screws 408, adapted to respective housing screw apertures 416, hold the housing 402, 404 in an assembled configuration.

The jetting head 400 further comprises a jetting tube 432, a piezo-electric transducer 434 and a reagent fluid supply tube 430. The jetting tube 432 defines a tapered orifice 433 at one end and a fluid receiving aperture 431 at the other end for expelling and receiving fluid, respectively. The piezo-electric transducer 434 is cylindrically shaped and secured concentrically about the mid-region of the jetting tube 432 with epoxy or other suitable means.

The piezo-electric transducer 434, shown in Fig. 2e, defines a first and second end and comprises a section of cylindrically shaped piezeo-electric material 435. An inner nickel electrode 437 covers the inner surface of the cylinder 435. The electrode 437 wraps around the first end of the cylinder 435 a sufficient distance to enable electrical connection external to the cylinder 435.

A second nickel electrode 436 covers the majority of the outer surface of the cylinder 435. The second electrode is electrically isolated from the first electrode 437 by an air gap at the face of the second end of the cylinder 435 and by an air gap on the outer surface of the cylinder 435 near the first end. When an electrical pulse is applied to the first and second electrodes 437, 436 a voltage potential is developed radially across the transducer material 435. The voltage potential causes the radial dimensions of the transducer 435 to change, which causes the volume defined by the transducer 434 to also change.

The jetting tube 432 is positioned in the transducer chamber 403 such that the receiving end 431 extends beyond the rearward end of the transducer 434. The receiving end 431 of the jetting tube 432 is inserted into one end of a reagent supply tube 430. The supply tube 430 is sealingly held to the jetting tube 432 by concentric teeth 412 formed by the housing sections 402, 404. The teeth 412 not only seal the supply tube 430 to the jetting tube 432, but, also, seal the supply tube 430 to the housing 402, 404.

The second end of the supply type 430 passes through the channel 410 and into a reagent reservoir 200. The reservoir 200 contains the reagent fluid to be dispensed by the jetting head 400. As the reagent fluid is dispensed, air is supplied to the reservoir 200 through the channel 410 to prevent the creation of a vacuum in the reservoir 200. The reservoir 200 is releasably attached to the housing 402, 404 and held in place by frictional forces. A reservoir cap 202 is flexibly attached to the reservoir 200 and adapted such that the cap 202 may be used to secure the opening in the reservoir 200 when the reservoir 200 is disengaged from the housing 402, 404.

The position of the jetting tube 432 defines the horizontal plane of the jetting head 400. The jetting tube 432 and the transducer 434 are held in a pre-defined vertical relationship with respect to the housing 402, 404 by means of two upper vertical alignment pins 418 and two lower vertical alignment pins 418. The two upper vertical alignment pins 418 extend horizontally from the housing section 402 into the transducer chamber 403. Similarly, the two lower vertical alignment pins 418 extend horizontally from the housing section 404 into the transducer chamber 403. Each vertical alignment pin 418 is formed integrally with the respective housing sections 402, 404.

The jetting tube 432 and the transducer 434 are held in a predefined horizontal relationship with respect to the housing 402, 404 by means of four horizontal alignment pins 424. Two of the horizontal alignment pins 424 extend horizontally from the housing section 402 approximately midway into the transducer chamber 403. Similarly, two of the horizontal alignment pins 424 extend horizontally from the housing section 404 approximately midway into the transducing chamber 403. Each horizontal alignment pin 424 is formed integrally with the respective housing section 402, 404. The alignment pins 418, 424, sealing teeth 412 and orifice aperture 406 are aligned and adapted to hold the jetting tube 432 and transducer 434 such

that the orifice 433 of the jetting tube 432 extends into the orifice aperture 406.

An electrical transducer activation pulse is supplied to the piezo-electric transducer 434 from the jetting head control unit 500 by means of two contact pins 422. A quantity of fluid will be dispensed from the jetting tube for each applied activation pulse. The activation pulse can be produced by a variety of conventional circuits or commercially available units. Therefore a detailed description of such a circuit will not be provided. However, a circuit for producing a series of activation pulses is provided in the description of the printing embodiment below. Due to the dif fering constraints involved in dispensing and printing, the circuit in the printing embodiment is not required to produce only a single pulse. However, one skilled in the art could, if desired, modify the circuit to produce a single pulse on demand for use in the dispensing embodiment.

Each contact pin 422 defines an enlarged head 423 which is adapted to contact the respective first and second electrodes 437, 436 located on the outer surface of the transducer 434. Two contact pin holders 414, integral with the housing 402, 404, are positioned to hold the respective contact pins 422 under the pin heads 423 such that each pin head 423 electrically engages the appropriate electrode 437, 436 of the transducer 434. Two contact pin engaging posts 420 extend from the housing 402, 404 opposite the contact pin holders 414 to engage and hold the contact pins 422 against the contact pin holders 414. The ends of the contact pins 422 opposite the pin heads 423 extend through the housing 402, 404 by means of contact pin apertures 421. Since the housing sections 402, 404 are formed symmetrically to one another, the contact pins 422 may be optionally attached above the transducer 434.

In operation, the reservoir 200 containing reagent fluid is fastened to the jetting head 400 such that the fluid supply tube 430 extends into the reagent fluid. The filter 300 may be fitted to the free end of the supply tube 430 or positioned inside the reservoir 200. Air is supplied through the channel 410 around the supply tube 430 to prevent the reservoir 200 from falling below atmospheric pressure. The air is prevented from entering around the supply tube 430 and into the transducer chamber 403 by the seal created between the sealing teeth 412 and the supply tube 430. The jetting tube 432 may be primed by slightly pressurizing the reservoir 200 to cause the reagent fluid to travel through the supply tube 430 and into the jetting tube 432. Once primed, the fluid is prevented from substantially withdrawing from the jetting tube 432 by the surface tension of the reagent fluid at the orifice 433.

The transducer activation pulse is conducted to the contact pins 422 of the jetting head 400. The contact pins 422 communicate the high voltage pulse to the electrodes 437, 436 of the transducer 434 with polarity such that the concentrically mounted transducer 434 expands. The rate of expansion is controlled by the rise time of the high voltage pulse which is preset to generate a rapid expansion. The expansion of the transducer 434 causes the jetting tube 432, which is epoxied to the transducer 434, to also expand. The expansion of the tube 432 generates an acoustic expansion wave interior to the tube 432 which travels axially towards the orifice 433 and towards the fluid receiving aperture 431. When the expansion wave reaches the orifice 433, the reagent fluid is partially drawn inwardly. However, the surface tension of the fluid acts to inhibit substantial inward fluid movement.

When the expansion wave reaches the end 431 of the tube 432, the expansion wave is reflected and becomes a compression wave which travels towards the center of the piezo-electric tube 434. The high voltage pulse width is adapted such that when the reflected compression wave is beneath the piezo-electric tube 434, the high voltage pulse falls, resulting in a de-expansion of the transducer 434 and the jetting tube 432. This action adds to the existing acoustic compression wave in the interior of the jetting tube 432. The enhanced compression wave travels toward the ori fice causing reagent fluid to be dispensed from the tube 432. The fluid is propelled from the orifice 433 as a small droplet 2 and deposited in the selected mixing cell 904 positioned by the transportation unit 902. One droplet 2 is dispensed for each transducer activation pulse. This mode of dispensing is referred to as the drop on demand mode.

In some instances, the droplet 2 may be accompanied by at least one smaller satelite droplet. However, even if satelite droplets are present, the volume and velocity of the reagent droplets 2 are highly reproduceable. This reproduceability allows for precise dispensing of uniform, controllably sized droplets 2 of reagent fluid into the mixing cell 904.

The droplets 2 of reagents impact the mixing cell 904 with sufficient force and volume to cause fluidic mixing of the reagents. Once the desired amounts of the selected reagents are deposited in the selected mixing cell 904, mixing cell 904 is transported to the detection station 906 where the mixed reagents may be extracted for use or analyzed for assay results.

The dispensing system 30 provides numerous advantages based upon the ability of the reagent jetting head 400 to rapidly and reproduceably eject uniform quantities of a wide range of reagents. The reaction times of some chemical processes are dependent upon the volume of the reagents used. The ability of the dispensing system 30 to dispense such minute amounts of reagents thereby reduces the processing time

of certain chemical assays. Furthermore, some chemical assays require a wide range of dilution ratios. Many conventional dispensing systems are unable to dispense the reagents in volume small enough to make the desired assay practical. The dispensing system of the pres ent invention overcomes this disadvantage.

In addition to dispensing reagent fluids, certain embodiments may be used for precision printing of reagents onto a printing medium such as filter paper to produce an assay test strip. A printing system 10 using the present invention is represented in Fig. 3. Structure similar in form and function to structure described above will be designated by like reference numerals. The printing system 10 comprises a reagent fluid reservoir 200, a filter 300, a reagent jetting head 400, a jetting head control unit 500, an interface 600, a computer 700, and an x-y plotter 800.

The x-y plotter 800 is a commercially available pen plotter, mechanically modified in a conventional manner such that the pen is replaced with the jetting head 400. The general operation and structure of the plotter 800 will not be described in detail. The plotter 800 accepts commands from the computer 700 thru a standard RS-232 serial interface contained within the interface unit 600. The plotter 800 processes the commands and produces control signals to drive an x-axis motor (not shown) and a y-axis motor (not shown). The x-axis motor is used to position the jetting head 400 and the y-axis motor is used to position a drum (not shown) to which the printing target 1 is attached.

The plotter 800 produces a pen down signal PENDN. This signal is applied to the control unit 500 and indicates that the plotter 800 is ready to begin a printing operation.

The control unit 500 also receives control signals from the interface unit 600. These signals include signals HIGHER*, LOWER* to control the magnitude of the pulse applied to the transducer 434; a reset signal RST to reset the control unit 500; and a series of print signals PRT*. The generation of these signals will not be described in detail since their production is performed by the conventional interface unit 600.

The jetting head 400 and fluid supply system 200, 300 are initialized and operate substantially as described above. The jetting head control unit 500, shown in Figs. 5a - 5e comprises a print control circuit 510, a pulse generator 530, a high voltage supply 540, and a strobe pulse generator 560. The control unit 500 also comprises a power supply. However, since the power supply is of conventional design it will not be shown or described in detail.

The print control circuit 510 receives the pen down signal PENDN from the plotter 800 and comprises a transistor Q100, a one-shot circuit U100. two NAND-gates U101, U102, a line decoder multiplexer U107 and four inverters U103-U106. The pen down signal PENDN is applied to the base of the transistor Q100 by resistors R100, R101 and diode D100. The emitter of transistor Q100 is tied to ground and the collector is connected to the +5 volt supply by resistor R102.

The one-shot U100 comprises inputs A, B and an output Q. The B input of the one-shot U100 is connected to the collector of the transistor Q100 and the A input is tied to ground. The time period of the pulse produced by the one-shot U100 is determined by a resistor R104, a variable resistor R105 and a capacitor C100. The output Q of the one-shot U100 is combined with the collector output of the transistor Q100 by the NAND-gate U101 and then inverted by the NAND-gate U102. The circuit is operative to produce an adjustable delay in the application of the pen down signal PENDN to the control unit 500.

The line decoder U107 is circuited to function as a 3 input AND-gate. The output of the NAND-gate U102 is applied to the first input of the decoder U107; the print signal line PRT* comprising a series of pulses from the interface unit 600 is applied to the second input; and a jetting head ON/OFF signal from switch S1 is applied to the third input. The inverter U106 inverts the output of the line decoder U107 to generate the print control signal PRT* and the inverters U103-U105 invert the control signals LOWER*, HIGHER*, and RST signals, respectively.

The high voltage supply 540, shown in Fig. 5b, provides +175 volts DC to produce a maximum pulse of +150 volts peak to peak at the reagent jetting head 400. The high voltage supply 540 comprises differential amplifier U12 and transistors Q1, Q2, Q13, Q14. A stable reference voltage of -2.5 volts DC is produced at the junction of a reservoir R13, connected to the -15 volt supply, and a diode CR6, connected to ground. The reference voltage is combined with a resistor R14 to produce an adjustable, stable voltage reference for the amplifer U12. The reference voltage is applied to the inverting input of the amplifier U12 through a resistor R11. The noninverting input of the amplifier U12 is connected to ground by a resistor R12. The amplifier U12, in combination with a feedback resistor R10, produces an output signal proportional to the difference of the voltage reference signal and the ground potential.

The output of the amplifier U12 is applied to the base of the transistor Q2 whose collector is connected to the +15 volt supply. The signal produced at the emitter of the transistor Q2 is applied to the base of the transistor Q1 through resistors R8, R6, R5, a transformer L1 and diodes CR4, CR2, CR1. The emitter of the transistor Q1 is connected to ground and the collector is connected to the +15 voltage supply through the

transformer L1. A diode CR3 connects the collector of the transistor Q1 to the junction of the resistor R5 and the diode CR4. The transistor Q1 is biased for proper operation by resistors R7, R6, R5. The resistor R7 and a capacitor C22 connect the junction of the resistor R8, R6 to the +15 voltage supply.

The transistor Q1 and the transformer L1 form a "flyback" blocking oscillator. Any increase in current supplied by the transistor Q1 produces an increase in energy transferred through the secondary winding of the transformer L1 and diode CR5. Therefore, an increase in current supplied by the transistor Q1 results in an increase in power available to the high voltage output. The diodes CR1-CR4 form a "Baker clamp" which prevents transistor Q1 from saturating. The clamp thereby avoids transistor storage time.

The diode CR5 is connected to a multiple pi filter formed by the inductors L3, L2, capacitors C24, C21, C41 and resistors R29. The multiple pi filter attenuates ripple and switching spikes in the signal supplied to the transistor Q13 which produces the high voltage output V++. A resistor R64 connects the base of the transistor Q13 to the emitter and to the resistor U29. The base is also connected to the collector of the transistor Q14 by a resistor R65. The base of the transistor Q14 is connected to the +15 volt supply by a resistor R67 and to ground by a resistor R66. The emitter of the transistor Q13 provides a signal HV SENSE which is fed back to the inverting input of the amplifier U12 through a resistor R9. The high voltage output V++ is produced at the collector of the transistor Q13. The proper biasing of the transistor Q13 is provided by resistor R64 and the biasing circuit comprising the transistor Q14, resistors R67, R66, R65.

The pulse generator 530, shown in Figs. 5d, 5e, comprises an opto-isolator U18, a one-shot U23, a digital to analog (D/A) converter U30 and two binary counters U24, U25. The pulse generator 530 accepts control signals PRT*, LOWER*, HIGHER*, RST and produces the activation pulse which is applied to the transducer 434. In normal operation, the PRT* control signal is supplied to the opto-isolator U18 by a jumper JMP between contact points E5, E6. The opto-isolator U18 is of conventional design and comprises a light emitting diode (LED) circuit and a photo-element circuit. A resistor R15 operates as the load resistor for the LED circuit of the isolator and a capacitor C25 suppresses transient noise on the voltage supply to the isolator U18. The output of the isolator U18 is applied to one input of the one-shot U23 whose time constant is adjustably determined by resistors R38, R25 and a capacitor C30. The pulse from the non-inverting output of the one-shot U23 is fed to the base of a transistor Q9. A resistor R39 sets the approximate base current of the transistor Q9 which is used as a level shifter for converting the CMOS signal level to the +15 volt DC signal level.

The control of the rise and fall rates of the pulse generator 530 is accomplished by directing a pair of current source transistors Q11, Q12 to charge and discharge a capacitor C57. The transistor Q11 is operative as a source of current and the transistor Q12 is operative as a sink for current. A transistor Q10 controls the level of the current by applying an appropriate bias current through a resistor R56 to the base of the transistor Q11. The biasing of the transistors Q11, Q12 is critical to the proper rise and fall rates. Therefore precision voltage references CR13. CR15 are used to provide respective bias reference voltages. A temperature compensation network is formed from zener diodes CR14, CR16 and resistors R55, R54 to maintain stable operation of the transistors Q11, Q12, respectively. The variable resistors R49. R52 may be used to adjust the fall time and rise time, respectively, of the output pulse applied to the reagent jetting head 400. A plurality of resistors R45. R46, R47, R48, R49, R51, R52, R53, R56, R57, R58 are used to properly bias the transistor Q10, Q11, Q12 and capacitors C55, C60 are circuited to maintain stability of the circuit.

The impedance of the output stage of the rise and fall circuitry Q10, Q11, Q12 is very high. With such a high impedance, circuit elements attached to the capacitor C57 could affect the linearity of the rise and fall time constants. Therefore, an FET input operational amplifier U32 is used as an impedance interface. The amplifier U32 is configured in the noninverting mode and circuited with capacitors C58, C59 for stability.

The output of the amplifier U32 is applied to an inverting amplifier U31 by means of a resistor R62. The amplifier U31 inverts and conditions the pulse control signal with the aid of resistors R59, R60. Resistors R61, R63, connected to the -15 voltage supply, provide a means for adjusting the DC level offset of the amplifier U31 output signal. Capacitors C51, C52 are connected to enhance the performance and stability of the circuit.

The output of the amplifier U31 is applied by means of a resistor R41 to the positive voltage reference signal input REF(+) of the D/A converter U30. The negative voltage reference signal input REF(-) is tied to ground by a resistor R40. The D/A converter U30 produces output signals IOUT, IOUT* which are proportional to the difference between the positive and nega tive voltage reference signal inputs REF(+). REF(-). Capacitors C48, C49, C50 are connected to the D/A converter U30 to enhance stability.

The D/A converter outputs IOUT, IOUT* are also proportional to an 8-bit binary value applied to inputs B1-B8. The binary value is supplied by the counters U24, U25 which are controlled by the function signals LOWER*, HIGHER* and RST. The LOWER* signal and the HIGHER* signals are applied to the count up and

count down inputs CU, CD of the counter U24 by means of opto-isolators U19, U20. The carry and borrow outputs CY, BR of the counter U24 are connected with the count up and count down inputs CU, CD of the counter U25. The reset inputs RST of both counters U24, U25 receive the RST signal by means of an opto-isolator U21. Resistors R16, R17, R18 are used as load resistors for the LED circuits of the isolators U19, U20, U21 and capacitors C26, C27, C28 are used to enhance the stability of the isolator circuits.

The counters U24, U25 may optionally be preloaded to the selected 8-bit binary value through input lines TP0-TP7. The input lines TP0-TP7 are normally biased to the logical high signal state by resistive network U22. The selected binary value is loaded into the counters U24, U25 by pulling the respective inputs TP0-TP7 low and applying an external, active low, load signal EXT LOAD to pin TP8. The load signal pin TP8 is connected to the load inputs LOAD of the counters U24, U25 and conditioned by a clipping circuit comprised of diodes CR9, CR10 and a pull-up resistor of the resistor network U22.

The noninverted and the inverted outputs IOUT, IOUT* are connected to the inverting and noninverting inputs of a differential amplifier U29. The output of the amplifier U29 is fed back to the invert ing input by a resistor R50. The amplifier U29 converts the current output of the D/A converter U30 to a voltage output. Capacitors C56, C47 are provided to enhance circuit stability.

The output of the amplifier U29 is applied to the noninverting input of the amplifier U28. The output of the amplifier U28 is fed back to the inverting input by means of a capacitor C46 and a resistor R37. The inverting input is also connected to ground by a resistor R36. To enhance the frequency response of the amplifier U28, a resistor R43 and a capacitor C54 are connected between the frequency compensation input FC and ground. An adjustable DC offset is provided by connecting the output offset inputs OF, OF with a variable resistor R42. The wiper of the resistor R42 is connected to the high voltage power supply output V+ +.

The output of the amplifier U28 is also connected to the base of a transistor Q4 and through diodes CR11, CR12 to the base of a transistor Q7. The transistor Q4, Q7, Q3 and resistors R30-R35 form an output circuit capable of driving high capacitive loads at high slew rates and wide bandwidth. The variable resistor R31 may be used to set the maximum current through the bias network R30, R33 by measuring the voltage drop across resistor R35.

The strobe generator 560 produces a strobe pulse and comprises transistors Q101-Q105 and a one-shot circuit U108. The strobe intensity is determined by the circuit comprising the transistors Q101-Q104 and resistors R109-R115. The circuit is connected to the anode of the LED 900 and receives two inputs from the interface unit 600 to produce four levels of light intensity in the LED 900.

The activation aand duration of activation of the LED 900 is determined by the one-shot U108 and the transistor Q105. The one-shot U108 comprises inputs A, B and an output Q. The strobe signal STROBE is applied to the B input from the interface unit 600. The duration of the one-shot U108 output pulse is controlled by the adjustable RC network R107, R108. The output Q is applied to the base of the transistor Q105 by resistor R108. The collector of the transistor Q105 is connected to the cathode of the LED 900 to draw current through the LED 900.

The computer 700, control unit 500 and plotter 800 must be initialized. The initialization of the computer 700 and the plotter 800 will not be discussed since these units are of conventional design and operation.

To initialize the jetting head control unit 500, the computer 700 directs the interface unit 600 to issue a reset command. The reset signal RST is conducted to the control unit 500 whereupon the counters U24, U25 are cleared. The computer 700 then retrieves from its memory, or by conventional operator input, the desired digital setting for the D/A converter. This setting may also be calculated from data and may be tailored to specific sizes of jetting heads 400 or reagent fluids. The computer 700 then issues a series of commands, through the interface unit 600, to increment or decrement the counters U24, U25 to correspond to the desired binary setting. If the command directs that the counters are to be raised, then the HIGHER* signal is applied through the opto-isolator U20 to the count up CU input of the counter U24. Similarly, if the command directs that the counters are to be lowered then the LOWER* signal is applied through the opto-isolator U19 to the count down CD input of the counter U24. Since the carry and borrow outputs CY, BR of the counter U24 are connected to the count up and count down inputs CU, CD, respectively, of the counter U25, the digital setting applied to the D/A converter U30 may range from 0 to 255. Alternately, the counters U24, U25 could be initialized to a desired setting by loading the binary value on the lines TP0-TP7 and strobing the EXT LOAD line.

Once the control unit 500 and the plotter 800 are initialized, the printing cycle may begin. The computer 700 issues a command to the interface unit 600 to produce the series of PRT* signal pulses. The computer 700 then commands the plotter 800 to print, for example, a line along a selected path. The plotter 800 positions the jetting head 400 and target 1 and issues the pen down signal PENDN. The signal is delayed by the print control circuit 510 to ensure that the target 1 is properly positioned. At the expiration of the

delay, the signal is ANDed with the closed enable switch S1 and the series of print pulses PRT*. The result of the AND operation is the application of the PRT* pulses to the pulse generator circuit 530.

The PRT* signal is applied through the jumper JMP to the opto-isolator U18 and then to the one-shot U23. The one-shot U23 produces a pulse signal which is then converted from CMOS signal levels to the 15 volt DC signal level by the transistor Q9. The rise and fall circuitry comprising Q10, Q11, Q12 converts the square wave pulse into a pulse having the rise and fall characteristics preset by the resistors R49, R52. The conditioned pulse is then amplified by the amplifier U32 and applied to the amplifier U31.

The amplifier U31 converts the polarity of the conditioned pulse to that acceptable by the D/A converter U30 and supplies an adjustable DC offset. The DC offset is used to counteract possible distortion attributable to the amplifier U31. The distortion arises in that, for the amplifier U31 to be adequately responsive, a small degree of current must flow through the resistor R41. This current creates an offset condition at the output of the amplifier U29 which is then scaled by the D/A converter U30 in correspondence with the binary data. The resistor R63 allows a small amount of current to be applied to the amplifier U31 to control the offset voltage attributable to the current flowing through the resistor R41.

The D/A converter U30 scales the difference between the inputs REF(+), REF(-) using the binary data supplied to input lines B1-B8 to produce a current output pulse IOUT and a current inverted output pulse IOUT*. The two outputs IOUT, IOUT* are fed to the amplifier U29 which convert the current outputs into a single voltage output. The scaled, conditioned pulse is then applied to the output circuit comprising the amplifier U28 and the transistors Q3, Q4, Q5, Q6, Q7. The circuit produces a high voltage pulse with the aforementioned rise and fall characteristics to drive the piezo-electric transducer 434.

The high voltage pulse is applied to the transducer 434 and causes a droplet 2 of fluid to be propelled onto the target 1. Since the pen down signal PENDN is still applied, additional droplets 2 are produced from the jetting head 400. The plotter 800 moves the jetting head 400 and target 1 along the desired path during the emission of the droplets 2 to produce the desired printed line. When the printing is complete, the plotter 800 removes the pen down signal PENDN and the droplet emission stops. Of course it should be understood that dots, circles and the like could be produced by appropriate positioning of the target 1 and jetting head 400.

The size and uniformity of the droplets 2, as well as the presence of any satelite droplets, may be observed with the aid of the scope 950 and the LED 900. The scope 950 and the LED 900 are positioned such that the droplets 2 pass between the scope 950 and the LED 900 and within the focal range of the scope 950. The strobe pulse when applied to the LED 900 causes the LED 900 to momentarily flash. The timing of the activation and the width of the pulse may be adjusted such that the flash occurs when the fluid, expelled in response to the high voltage pulse, is between the scope 950 and the LED 900. The dispensed quantity of fluid may then be observed in flight or at or near the momement of separation from the orifice 433. Corrections based on the observation may then be made to the system 10.

Since each droplet 2 is small in volume, the droplet 2 may be rapidly absorbed by the target 1, thereby allowing rapid and precise placement of a variety of reagents on the target 1 with reduced drying time and reduced potential of fluidity mixing. In addition, the ability to place small droplets 2 in a precise manner enables the target 1 to be printed in a high density matrix with a variety of reagents as isolated matrix elements.

In some printing applications, particularly when printing fluids of flow viscosity and surface tension, it may be desirable to force the fluid through the jetting tube 432 under pressure and allow the vibrations produced by the transducer 434 to break the emitted fluid stream into precise droplets 2. Under this mode of printing, the emission of droplets 2 can not be stopped by cessation of the transducers activation pulse. It is therefore necessary to prevent fluid emission by other means. One preferred means of momentarily stopping emission of the droplets is shown schematically in Fig. 4. In this arrangement, structure similar to structure represented in Fig. 3 in form and function, is represented by like reference numerals.

The arrangement, generally represented by the numeral 20, includes a closed reagent recirculation system comprising a normally close three way valve 970, a sump 960 and a recirculation pump 980. In the continuous mode, the reagent fluid is forced out the orifice 433 by hydraulic pressure and broken into a series of substantially uniform droplets 2 by movement of the transducer 434. A regulated, filtered air supply 100 is used to pressurize the reagent fluid reservoir 200. The reagent fluid within the reservoir 200 may optionally be agitated by a magnetic stirer unit 990. This is especially useful for reagent fluids comprising suspended particles.

The three-way valve 970 comprises a common channel, a normally open channel and a normally closed channel. The fluid is forced through the filter 300 and applied to the normally closed channel of the valve 970. When the normally closed channel is closed, the normally open channel of the valve 970 functions as a vent for the reagent jetting head 400. The common channel is connected to the reagent supply tube 430

of the jetting head 400. The reagent supply tube 430 is also connected to the sump 960.

In operation, the normally closed channel is opened by an appropriate signal supplied by the computer 700 which also closes the normally open channel. When the normally closed channel is opened, fluid is permitted to pass to the sump 960 and to the jetting head 400. The sump 960 collects the reagent fluid not transferred to the jetting head 400. The sump 960 supplies the collected fluid to the inlet side of the recirculating pump 980 which returns the fluid to the reservoir 200. The returned fluid is then mixed with the contents of the reservoir 200 and is available for recirculation.

When operating in the continuous mode, rather than interrupt the continuous stream of print pulses to the jetting head 400, the printing may be momentarily stopped by closing the normally closed channel of the valve 970. The closing of the normally closed channel stops the flow of reagent fluid to the jetting head 400 and allows the jetting head 400 to vent to atmospheric pressure. With the fluid supply blocked, the transducer 434 is unable to expel further droplets 2. Thus, if positioning of the target 1 by the plotter 800 requires a longer time interval than the time between droplet 2 emission, the computer 700 may close the normally closed channel of the valve 970. The plotter 800 may then position the target 1 or position a new target 1 as desired.

When printing, the active ingredient of the reagent is tailored to achieve a desired concentration per unit area on the target 1. However, to a certain extent the final concentration per unit area can be adjusted by varying the density of the droplets 2 printed on the target 1. The preferred embodiment is particularly well suited to this application due to its ability to print precise, discrete pels of reagent.

A second preferred embodiment of the jetting head is illustrated in Figs. 6a-6b and is generally represented as 400'. The jetting head 400' comprises housing formed into three sections 401', 402', 403'. The housing section 403' comprises a recessed region which forms the reagent fluid reservoir 200' when the housing section 403' is positioned against housing section 402'.

The jetting head 400' further comprises a piezo-electric transducer 434' and a reagent jetting tube 432' similar to those of the first embodiment. The jetting head 400' and the transducer 434' are most clearly shown in Fig. 6b. The jetting tube 432' defines an orifice 433' at one end and a reagent fluid receiving aperture 431' at the other end. The transducer 434' is mounted to the jetting tube 432' concentrically about the mid-region of the tube 432' with epoxy.

The transducer 434' and the jetting tube 432' are positioned in channels 420', 418', 416' located in the housing sections 402', 401'. The channel 416' comprises a plurality of sealing teeth 412' operative to engage and seal against the fluid receiving end 431' of the jetting tube 432'. The channel 416' is connected to the reagent fluid supply channel 430'. The supply channel 430' is connected with the fluid reservoir 200' by means of an aperture 431' through the housing section 402', shown in Fig. 6b.

The reservoir 200' comprises a flexible reservoir lining 201' adapted to contain the reagent fluid. The lining 201' comprises one aperture which is connected to the housing 402' to allow the fluid to pass from the lining 201'. A vent (not shown), located in the housing 403', allows the space between the reservoir 200' and the lining 201' to be vented or pressurized. A filter 300' is positioned within the aperture 202' to trap unwanted particulate foreign matter.

Electrical pulses are supplied to the transducer 434' by means of two contact pins 422'. The pins 422' are inserted through respective apertures 419' of the housing section 402' and respective apertures 421' of the housing section 403'. Two thin electrically conductive strips 410', 411', shown in Fig. 6b, are used to connect the transducer 434' with the contact pins 422'. A protective shield 405' extends from the housing position 403' to partially isolate the protruding portions of the contact pins 422'.

The function and operation of the jetting head 400' is similar to that of the jetting head 400 and therefore will not be discussed in detail. The collapsible inner lining 201' of the reservoir 200 allows the jetting tube 432' to be primed by pressurizing the reservoir 200' through the vent 205'. Once primed, the jetting head 400' may be used as described above in reference to the jetting head 400.

The jetting head 400' provides an advantage in that the entire fluidic system is contained in one housing. Such containment allows for fast and efficient replacement of the jetting heads without fluid contamination problems.

A third preferred embodiment of the jetting head is shown in Fig. 7 and generally represented as 400". The jetting head 400" comprises a housing 403", a reagent fluid supply tube 406", a piezo-electric transducer 434" and an orifice plate 404". The housing 403" defines a conically shaped fluid chamber 432". An orifice plate 404", defining an orifice 433", is fastened to the housing 403" such that the orifice 433" is located at or near the apex of the conical fluid chamber 432".

The fluid feed tube 406" is attached to the housing 403" and defines a supply channel 430". The supply channel 430" is in fluid communication with the fluid chamber 432" by means of a connecting channel 431". The base of the fluid chamber 432' is formed by the disc-shaped transducer 434". The transducer 434" is

held in position by a hold down plate 402" attached to the housing 403". The electrical connec tions to the transducer 434" are of conventional design and are therefore not shown. The housing 403" further comprises a threaded aperture 406" for mounting the jetting head 400".

The jetting head 400" operates in a manner similar to the jetting heads described above. However, in this jetting head the transducer 434" is normally disk shaped. When the electrical pulse is applied, the transducer 434" bends slightly, thereby altering the volume of the conically shaped jetting chamber 432". The change in volume of the chamber 432" causes the expulsion of fluid through the orifice 433" and the intake of fluid through the supply channel 430" as described in reference to the jetting head 400.

A fourth preferred embodiment of the jetting head is shown in Fig. 8 and is generally represented as 400"" . The jetting head 400"" is very similar in form and function to the jetting head 400 and will not be described in detail. The jetting head 400"" comprises two symmetrical housing sections. The sections may be connected together by means of apertures 409"" and screws, not shown. When assembled, the housing sections 404"", 402"" form a T-shaped supply channel 410"" .

In operation, the jetting head 400"" functions in a manner similar to the jetting head 400. The jetting head 400"" is especially suited for use in the continuous mode, but may also be used in the drop on demand mode. In the continuous mode, the fluid is circulated continuously through the supply channel 430"" allowing the jetting tube 432"" to withdraw as much fluid as required.

By way of illustrating and with no limitations intended the following information is given to further illustrate the above described embodiments. The computer 700 is an IBM Corporation Personal Computer with 640 kbytes of RAM memory. The interface unit 600 is a Burr Brown interface unit model number PC 20001. The plotter 800 is manufactured by Houston Instrument as model number DMP-40. Communication between the plotter 800 and the interface unit 600 is performed through a standard asynchronous serial communication port.

The electrical pulse applied to the jetting head 400 to activate the transducer 434 comprises a rise time of approximately 5 usecs, a fall time of approximately 5 usecs and a pulse width of approximately 35 usecs. When the transducer 434 is operated in the drop on demand mode, the voltage potential of the pulse is 60 volts plus or minus 10 volts and the pulse frequency can be up to 4 khz. When the transducer 434 is operated in the continuous mode, the voltage potential of the pulse is 30 volts plus or minus 10 volts and the pulse frequency can be up to 10 khz.

The jetting tube 432 is manufactured from a pyrex glass tube and measures .027 inches outside diameter and .020 inches inside diameter. The tube is drawn to a closed taper in an electric furnace. The tapered end is then cut and ground to a desired orifice opening of .002 to .004 inches in diameter. The tube is cut to a final length of .945 inches in the case of the dispenser embodiment and ultrasonically cleaned in acetone. After being cleaned and dried the large end of the tube is fire polished. If desired, the orifice end of the tube may receive a coating, such as a hydrophobic polymer, to enhance droplet separation from the tube.

The supply tube 430 is formed from .023 inch inside diameter and .38 inch outside diameter polyethylene tubing produced by Intramedic Corp. as model number #14 170 11B. During assembly, one end of the tubing is stretched over a warm tapered mandrel. The stretched end of the supply tube 430 is then inserted over the large fire polished end of the jetting tube 432. The assembly is then cleaned and baked in a circulating air oven at 50°C. for 10 minutes.

The transducer 434 was purchased from Vernitron of Cleveland, Ohio as model number PZT-5H. The electrodes 437, 436 are comprised of nickel and are separated from each other on the outer surface of the transducer by approximately .030 inches. The jetting tube 432 is inserted into the cylindrical piezo-electric tube 434 and secured with epoxy manufactured by Epoxy Technology of Bellerica, Massachusetts as model number 301. The epoxy is applied at the junction of the tube 432 and transducer 434 with a syringe. The epoxy flows along the tube 432 inside the transducer 434 by capillary action. The assembly is then baked in a circulating air oven at 65°C. for one hour to cure the epoxy.

The contact pins 422 are secured to one of the housing sections 402, 404 with a drop of epoxy. The transducer jetting tube 434, 432 is placed in the housing such that the orifice end 433 of the tube 432 protrudes approximately .030 inches from the housing 403, 404. A drop of silver epoxy is placed between each contact pin 422 and the transducer 434 to ensure a secure electrical connection. Epoxy is also applied to the junction of the housing 402, 404 and supply tube 430. The other section of the housing 402, 404 is then screwed into place.

The periphery of the housing 402, 404 is sealed with a capillary sealer such as cyclohexanone. Epoxy is then added around each contact pin 422 and around the orifice end 433. The assembly is then baked in a circulating air oven at 65°C. for one hour.

The filter 300 is formed from a polyester mesh with 30 um pores and positioned in a polypropylene

housing. The air pressure supplied to the reservoir 200 during continuous printing operations is regulated at approximately 10 to 30 psi.

The reagents used have the following characteristics:

Printing (drop on demand mode):

Fluid viscosity range: 1 - 30 centipoises

Fluid surface tension: 20 - 70 dyne/cm

Printing (continuous mode):

Fluid viscosity range: up to 50 centipoises

Fluid surface tension: not measured

Dispensing (drop on demand mode):.

Fluid viscosity range: 2 - 30 centipoises

Fluid surface tension: 20 - 70 dyne/cm

A measure of the performance and selected operating characteristics for a typical jetting head are presented in Figs. 9-11. Fig. 9 is a graph of the mass of a droplet as a function of droplet emission frequency for three fluids. The viscosity of the fluids were 1, 5 and 24 centipoise and the transducer excitation pulse width was 35 microseconds. As shown in Fig. 9, the higher fluid viscosity results in a more stable operating performance of the jetting head. Fig. 10 is a graph of droplet velocity as a function of droplet emission frequency for fluid viscosities of 1, 5 and 24 centipoise. The log of the total fluid weight as a function of the log of the number of droplets emitted is shown in Fig. 11. The fluid used has a viscosity of 2 centipoise, a surface tension of 20 dynes/cm, and a density of .8 grams/cc. The transducer excitation pulse was 80 volts and the excitation frequency was approximately 711 Hz.

Some blood typing reagents and some allergen reagents have very low viscosities and surface tensions. Although in some cases viscosity modifiers, such as glycerol, dextran, glucose, and the like, may be added to increase the viscosity, a few reagents are adversely affected by such modifiers.

Developing stable and reproduceable demand mode jetting is difficult with very low viscosities. Although droplet emission can be established at some fundamental frequencies, the droplets dispensed may have small satelite droplets which reduce the accuracy for metering and dispensing applications. However, even with the satelite drops, sufficient reagent is adequately delivered for most print applications without a substantial decrease in print quality.

Glycerin may be used as a viscosity modifier to improve jetting reliability and to prevent obstruction of the orifice arising from evaporation of the reagent fluid components. Glycerin has been found especially beneficial for those reagents containing particulate material. The evaporation of the fluid component results in a concentration of glycerin located at the orifice. The plug of glycerin substantially prevents further evaporation of the reagent fluid. During the next activation cycle of the transducer, the plug of glycerin is expelled from the orifice.

When operating in the dispensing mode the volume of the droplets can be varied to substantially uniformly contain from 100 pico-liters to 1 micro-liter. The droplets can be produced at a rate of approximately 1 khz to 8 khz. When operating in the printing mode the size of the pel made by each droplet measures approximately .001-.012 inches in diameter.

A copy of the program used in the computer 700 for a printing operation is attached hereto as Appendix A. The values, manufacturer and manufacturing part number of the circuit components of the jetting control unit 500 are substantially as follows:

Ref. Numeral of Component	Description and Value	Manufacturer and Part No.
R39,45-48,57, 58	RES.10KOHM¼WATT5%C.F.	
R66	RES.150OHM¼WATT5%C.F.	
R3	RES.15KOHM¼WATT5%C.F.	
R34	RES.16KOHM¼WATT5%C.F.	
R50	RES.2.4KOHM¼WATT1%M.F.	DALE RL079242G
R13,23,36,40, 41	RES.2.4KOHM¼WATT5%C.F.	
R56	RES.20KOHM¼WATT5%C.F.	
R8	RES.220OHM¼WATT5%C.F.	
R6	RES.27OHM1WATT5%C.C.	
R7,12,25	RES.2KOHM¼WATT5%C.F.	
R67	RES3.6KOHM¼WATT5%C.F.	
R51,53	RES.3.9KOHM¼WATT5%C.F.	
R29	RES.300KOHM¼WATT5%C.F.	
R61	RES.30KOHM¼WATT1%M.F.	DALE RL079303G
R15-18,26-28, 54,55,64	RES.4.7KOHM¼WATT5%C.F.	
R62	RES.45.3KOHM¼WATT1%M.F.	DALE RN55D4532F
R30,33	RES.47OHM¼WATT5%C.F.	
R21	RES.4700HM¼WATT5%C.F.	
R19	RES.47KOHM¼WATT5%C.F.	
R35	RES.510OHM¼WATT5%C.F.	
R43	RES.6.2KOHM¼WATT5%C.F.	
R60	RES.7.5KOHM¼WATT5%C.F.	
R37	RES.75KOHM¼WATT5%C.F.	
R9	RES.76KOHM¼WATT1%M.F.	DALE RN60D7682F
R11	RES.820OHM¼WATT5%C.F.	
U2,11,14,16,22	RES.DIP NETWRK.47KOHM	CT9 761-1R47K
C21,41,45	CAP.AXIALIMF@250VDC	MALLORY #TC56
C24	CAP.AXIAL220MF@250VDC	MALLORY LP2219250C7P3
C10	CAP.AXIAL ALUM ELEC. 4700 OMF@25VDC	MALLORY TCG472U025NIC
C1,2,3,55,60	CAP.RADIAL DIPPED TANT. 10MF@25VDC	KEMET T350E106M025AS
C53	CAP.RADIAL DIPPED TANT. 1MF@35VDC	KEMET T350A105K035AS
C36	CAP.RADIAL DIPPED TANT. 47MF@10VDC	KEMET T350H566MC10AS

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Ref. Numeral of Component	Description and Value	Manufacturer and Part No.
C54	CAP.RADIAL SILV MICA 100PF300VDC	KAHGAN SD5101J301
C57	CAP.RADIAL SILV MICA 20PF300VDC	KAHGAN SP12200J301
C49	CAP. RADIAL SILV. MICA 39PF300VDC	KAHGAN SP12390J301
C39	CAP.RADIAL X7R MLC .015MF@50VDC	KEMET C315C102K1R5CA
C6	CAP.RADIAL X7R MLC .022MF@50VDC	KEMET C315C223K5R5CA
C30,35,37	CAP.RADIAL Z5U MLC .015MF@50VDC	KEMET C315C153K5R5CA
C4,7	CAP.RADIAL 25U MLC .01MF@50VDC	KEMET C315C103K5R5CA
C4,5,6,9,11-19, 22,23,25-28 C31-34,37,42,43 47,48,50-52 C56,58,59	CAP.RADIAL 25U MLC .22MF@50VDC	KEMET C322C224M5U5CA
C46	CAP.VARI.2-12PF.	JOHANSEN #9626
CR7,8,9,10, 11,12,17	DIODE SIL.	ITT.FAIRCHLD.1N4148
CR1,2,3,4	DIODE SIL.FAST	GENL.INST.EGP10D
CR5	DIODE SIL.FASTHIVOLT	GENL.INST.UF4007
CR6,13,15	DIODE SIL.REF.2,500VDC	NATL.SEMI-LM3852-2.5
CR14,16	DIODE SIL.ZENER3.8V.25WATT	MOTOROLA 1N4622A
U6,13,15,17	SWITCH 8 POSITION DIP	CTS 206-8
Q2,9,12	TRANSTOR.COMMON NPN	MOTOROLA 2N2222A
Q8,10,11	TRANSTOR.COMMON PNP	MOTOROLA 2N2907A
Q4	TRANSTOR.HIVOLTHIFREQ.NPN	MOTOROLA MPSU10
Q7	TRANSTOR.HIVOLTHIFREQ.PNP	MOTOROLA MPSU60
Q1	TRANSTOR.HIVOLTHIINPN	TI,MOTOROLATIP48
Q3,14	TRANSTOR.HIVOLTNPN2N3439	MOTOROLA 2N3439
Q13	TRANSTOR.HIVOLTPNP	MOTOROLA MJE5731
U5,27	IC 1-SHOT 74HC221	NATL.SEMI MM74HC221N
U23,26	IC 1-SHOT 74LS221	NATL.SEMI DM741S221N
U7-10	IC COMPARATOR 74HC688	NATL.SEMI MM74HC688N
U30	IC CONVERTER DAC0800	NATL.SEMI DAC0800LCN
U24,25	IC COUNTER 74HC193	NATL.SEMI MM74HC193N
U28	IC HI SLEW HI VOLT OP AMP	BURR-BROWN 3584JM
U1	IC HYBRID DC/DC CONVERTER	BURR-BROWN MODEL 724
U4	IC OC DRIVER SN7406	NATL.SEMI DM7406N
U3	IC OCTAL LATCH 74HC374	NATL. MM74HC374N
U12,29,31,32	IC OP AMP LF256	NATL.SEMI LF256H
U18,19,20,21	IC OPTO ISOLATOR	HEWLTT-PCKRD HCPL2300
R24,42,63	POT100KOHM¼WATT10%	BOURNS 3622-1-104
R38,49,52	POT10KOHM¼WATT10%	BOURNS 3622W-1-103
R20	POT25KOHM¼WATT10%	BOURNS 3622W-1-253
R14,31	POT2KOHM¼WATT10%	BOURNS 3622W-1-202

Ref. Numeral of Component	Description and Value	Manufacturer and Part No.
VRI	REGULATOR 5VDC	NATL.LM340T-5.0
R10	RES.1MEGOHM¼WATT5%C.F.	
R2,4	RES.1.2KOHM¼WATT5%C.F.	
R32	RES.1.6KOHM¼WATT5%C.F.	
R44	RES.1.8KOHM¼WATT5%C.F.	
R1	RES.10MEGOHM¼WATT5%C.F.	
R5,R22	RES.100HM¼WATT5%C.F.	
R65	RES.100KOHM¼WATT5%C.F.	
R59	RES.10KOHM¼WATT1%M.F.	DALE RN55D1002F
R100	RES.270OHM	
R101,108	RES.470OHM	
R102,103 106,109,110	RES.1KOHM	
R104	RES.47000HM	
R105	POT.100KOHM	
R107	POT.10KOHM	
R111,113	RES.220OHM	
R112	RES.22OHM	
R114,115	RES. 47OHM	
C100	CAP.10MF035 VPC	
C108	CAP.10000 PF	
D100	DIODE	1N4148
Q100,105	TRANSTOR	2N2222
Q101,102	TRANSTOR	2N3906
Q103,104	TRANSTOR	2N3904
U100,U108	IC I-SHOT	74LS123
U103,104 105,106	IC INVERTOR	74LS04
U108	IC LINE DECODER	74LS138

Of course, it should be understood that a wide range of changes and modifications can be made to the preferred embodiments described above. For example, the transducer could be of a type other than piezo-electric such as magneto-strictive, electro-strictive, and electro-mechanical. It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents, which are intended to define the scope of this invention.

APPENDIX

```
Reagent Jet Printer                                                    PAGE  1
Reagent Calibration                                                    07-14-86
                                                                       12:26:57
Offset  Data    Source Line                          IBM Personal Computer BASIC Compiler V2.00

0030  0006    REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Reagent Calibration' $LINESIZE: 132
0030  0006    'MODULE   - "REACAL"
0030  0006    '
0030  0006    'AUTHOR   - M. A. Enevold
0030  0006    '
0030  0006    'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030  0006    'REVISION - 2.0 07-01-86 NAE MicroFab modifications
0030  0006    '         - 1.0 02-11-86 NAE Creation of initial code
0030  0006    '
0030  0006    'SYSTEM   - This code can only be compiled by the BASCOM
0030  0006    '           COMPILER, it will not run under the INTERPRETER!!
0030  0006    '
0030  0006    'DESCRIPTION:
0030  0006    '       The reagent calibrate module presents a menu with 12 items arranged
0030  0006    '       in 3 columns of 4 rows.  The arrow keys allow movement around the
0030  0006    '       table, the + and - keys increment or decrement values in the first
0030  0006    '       column, and the enter key executes commands in the third column.
0030  0006    '       The second column is an array of ASCII strings representing reagent name,
0030  0006    '       concentration, density, and viscosity.  The values entered in column one
0030  0006    '       are drop frequency, pulse width, strobe delay, and nozzle number.
0030  0006    '       The commands in the third column are start/stop, load, save, and exit.
0030  0006    '
0030  0006    'DATA DICTIONARY
0030  0006    '       MENU%         Pointer to which menu item is active (0-11)
0030  0006    '       MENU$(17,1)   Array for strings used to display the menu
0030  0006    '       MENU(17,4)    Array for numbers in the menu display
0030  0006    '       DIFF%         Differential to move MENU% at arrow key input
0030  0006    '       TYPE%         Pointer set during main scan to direct action
0030  0006    '       KEYBUF$       Storage for string input from menu display
0030  0006    '       A$            Destination for single keystroke inputs
0030  0006    '       FILE$         String where filename is built for reagent data file
0030  0006    '       REANAME$      String where reagent name is stored
0030  0006    '       R%            Row to display special graphics character in menu
0030  0006    '       C%            Column to display special graphics character in menu
0030  0006    '       M%            Special graphics character is read into here
0030  0006    '       DLD.AMP.VALUE% Integer value for setting pulse amplitude
0030  0006    '       DIG.VAL%      Value set to digital port 0 to inc/dec amplitude
0030  0006    '
0030  0006    SUB REAGENT.CALIBRATE STATIC
0047  0006
0047  0006            DIM MENU$(17,1),MENU(17,4)
0048  01FE
0048  01FE            GOSUB INITIALIZE:       'read init. values and set screen
004E  01FE
004E  01FE            WHILE TYPE% <> 1
0059  0200
0059  0200              TYPE% = 0
0060  0200              A$ = ""
006A  0204
006A  0204              WHILE A$ = ""
0079  0204                A$ = INKEY$
00B3  0204                IF ACTIVE% = 1 AND DOWNTIME < TIMER THEN GOSUB PEN.DOWN
00AD  020A              WEND
00B0  020A
```

```
Reagent Jet Printer                                                                    PAGE   2
Reagent Calibration                                                                    07-14-86
                                                                                       12:26:57
Offset  Data    Source Line                                  IBM Personal Computer BASIC Compiler V2.00

00B0    020A            IF A$ = CHR$(13) THEN TYPEZ = 1:            'execute (cr)
00CA    020A            IF A$ = "+" THEN TYPEZ = 2:                 'increment variable
00E0    020A            IF A$ = "-" THEN TYPEZ = 3:                 'decrement variable
00F6    020A            IF A$ = CHR$(0) + CHR$(72) THEN TYPEZ = 4:  'up arrow key
011B    020A            IF A$ = CHR$(0) + CHR$(80) THEN TYPEZ = 5:  'down arrow key
0140    020A            IF A$ = CHR$(0) + CHR$(75) THEN TYPEZ = 6:  'left arrow key
0165    020A            IF A$ = CHR$(0) + CHR$(77) THEN TYPEZ = 7:  'right arrow key
018A    020A            IF A$ > CHR$(47) AND A$ < CHR$(123) THEN TYPEZ = 8:' ascii 0 - z
01C2    020A
01C2    020A            ON TYPEZ GOSUB T1, T2, T3, T4, T5, T6, T7, T8
01DB    020A
01DB    020A          WEND
01DF    020A          TYPEZ = 0
01E6    020A
01E6    020A          EXIT SUB
01EA    020A    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  3
Reagent Calibration                                                    07-14-86
                                                                       12:26:57
Offset  Data    Source Line                          IBM Personal Computer BASIC Compiler V2.00

01EA    020A    '*********** SUBROUTINES FOR THIS MODULE ***********
01EA    020A
01EA    020A    T1:             '<cr> execute command
01EF    020A            IF MENU% < 12 THEN TYPE% = 0:RETURN:    'exit to print menu, no action
0205    020C            ON MENU% - 11 GOSUB T1A, T1B, T1C, T1D
021A    020C            IF MENU% < 15 THEN TYPE% = 0
022C    020C            RETURN
0230    020C
0230    020C    T1A:            'start/stop drop flow
0235    020C            IF MENU$(12,0) = "START" THEN GOSUB START.INK
025A    020C            IF MENU$(12,0) = "STOP " THEN GOSUB STOP.INK
027F    020C            MENU$(12,0) = TEMP$
029A    0210            COLOR 0,7:GOSUB DISPMENU
02AC    0210            RETURN
02B0    0210
02B0    0210    START.INK:
02B5    0210            TEMP$ = "STOP "
02BF    0210            CALL DOT.ON:            'in module PC1
02CB    0210            LOCATE 17,71:COLOR 27,0:PRINT "PRINTING";
02F1    0210            ACTIVE% = 1
02F8    0210            RETURN
02FC    0210
02FC    0210    STOP.INK:
0301    0210            TEMP$ = "START"
030B    0210            CALL DOT.OFF:           'in module PC1
0317    0210            LOCATE 17,71:COLOR 15,0:PRINT "       ";
033D    0210            ACTIVE% = 0
0344    0210            RETURN
0348    0210
0349    0210    T1B:            'load reagent profile
034D    0210            IF MENU$(6,1) = "" THEN LOCATE 25,1:PRINT "Reagent Name is not specified";:GOSUB ANYKEY:RETURN
0391    0210
0391    0210            GOSUB SEARCH
0397    0210
0397    0210            IF I% < (REANUM% + 1) THEN GOTO FOUND
03A8    0214            LOCATE 25,10-LEN(MENU$(6,1))/2:PRINT MENU$(6,1);" not Found";
0401    0214            GOSUB ANYKEY:   'wait for a keyhit
040A    0214            RETURN
040E    0214
040E    0214    FOUND:
0413    0214            FILE$ = RIGHT$(STR$(I%),LEN(STR$(I%))-1) + "REA.RJP"
0437    0218            OPEN FILE$ FOR INPUT AS #1:     'set pattern data file for read
0448    0218            INPUT #1,MENU(0,0):     'read frequency
0468    0218            INPUT #1,MENU(1,0):     'read amplitude
0488    0218            INPUT #1,MENU(2,0):     'read strobe delay
04AE    0218            INPUT #1,MENU(3,0):     'read pulse width
04D1    0218            INPUT #1,MENU(4,0):     'read rise time
04F4    0218            INPUT #1,MENU(5,0):     'read fall time
0519    0218
0519    0218            INPUT #1,MENU$(7,1):    'read concentration
0530    0218            INPUT #1,MENU$(8,1):    'read density
0561    0218            INPUT #1,MENU$(9,1):    'read viscosity
0585    0218            INPUT #1,MENU$(10,1):   'read surface tension
05A9    0218
```

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Reagent Jet Printer                                                          PAGE  4
Reagent Calibration                                                          07-14-86
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Offset  Data   Source Line                                  IBM Personal Computer BASIC Compiler V2.00

05A9   0218          CLOSE #1:       'done with data file
05B0   0218
05B0   0218          OPEN "READEF.RJP" FOR OUTPUT AS #1
05C2   0218          PRINT #1,FILE$:                 'save filename in default file
05D2   0218          PRINT #1,MENU$(6,1):    'save the directory name as well
05F4   0218          CLOSE #1
05FB   0218          GOSUB DISP.PARMS:       'show all parameters
0601   0218          RETURN
0605   0218
0605   0218    T1C:          'save reagent profile
060A   0218          IF MENU$(6,1) = "" THEN LOCATE 25,1:PRINT "Reagent Name is not specified";:GOSUB ANYKEY:RETURN
064E   0218          OPEN "READIR.RJP" FOR INPUT AS #1
065F   0218          INPUT #1,REANUM%
0671   0218          CLOSE #1
0678   0218          IF REANUM% < 80 THEN GOTO SAVE.REA
0687   0218          LOCATE 25,1:PRINT "Directory is Full (80 reagents max.)"
06A1   0218          GOSUB ANYKEY:RETURN
06AB   0218    SAVE.REA:
06B0   0218          GOSUB SEARCH
06B6   0218          IF I% > REANUM% THEN GOTO SAVEREA1
06C7   0218          REANUM% = I%
06CE   0218          COLOR 15,0
06DA   0218          LOCATE 25,1:PRINT MENU$(6,1);" already exists. Replace it with new values? ";
070C   0218          A$ = ""
0716   0218          WHILE A$ = ""
0725   0218                A$ = INKEY$
072F   0218          WEND
0732   0218          LOCATE 25,1:PRINT SPACE$(79);
074F   0218          IF A$ = "Y" OR A$ = "y" THEN GOTO REPLACE
0778   0218          RETURN
077C   0218
077C   0218    SAVEREA1:
0781   0218          KILL "READIR.OLD":      'delete old backup directory
078B   0218          NAME "READIR.RJP" AS "READIR.OLD":      'save old directory
0792   0218          OPEN "READIR.OLD" FOR INPUT AS #1
07A3   0218          OPEN "READIR.RJP" FOR OUTPUT AS #2:     'set up new dir
07B5   0218
07B5   0218          INPUT #1,REANUM%:       'read number of dir entries
07C7   0218          REANUM% = REANUM% + 1:  'increase by 1
07D9   0218          WRITE #2,REANUM%:       'save in new directory
07E1   0218
07E1   0218          FOR I=1 TO REANUM% - 1
07FA   021C             LINE INPUT #1,A$:    'read entry from old dir
0807   021C             PRINT #2,A$:         'write entry in new directory
0817   021C          NEXT I
0832   0220
0832   0220          CLOSE #1
0839   0220
0839   0220          PRINT #2,MENU$(6,1):    'write new entry to new directory
085B   0220          CLOSE #2:       'done with directory
0862   0220
0862   0220    REPLACE:
0867   0220          FILE$ = RIGHT$(STR$(REANUM%),LEN(STR$(REANUM%))-1) + "REA.RJP"
088B   0220
```

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Reagent Jet Printer                                                                    PAGE  5
Reagent Calibration                                                                    07-14-86
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Offset  Data    Source Line                                  IBM Personal Computer BASIC Compiler V2.00

0BBB    0220            OPEN FILE$ FOR OUTPUT AS #1:    'create new pattern data file
0B9D    0220            WRITE #1,MENU(0,0):     'store frequency
0BBB    0220            WRITE #1,MENU(1,0):     'store amplitude
0BDC    0220            WRITE #1,MENU(2,0):     'store strobe delay
0BFD    0220            WRITE #1,MENU(3,0):     'store pulse width
091E    0220            WRITE #1,MENU(4,0):     'store rise time
093F    0220            WRITE #1,MENU(5,0):     'store fall time
0962    0220
0962    0220            WRITE #1,MENU$(7,1):    'store concentration
0984    0220            WRITE #1,MENU$(8,1):    'store density
09A6    0220            WRITE #1,MENU$(9,1):    'store viscosity
09C8    0220            WRITE #1,MENU$(10,1):   'store surface tension
09EA    0220
09EA    0220            CLOSE #1:       'done with data file
09F1    0220
09F1    0220            OPEN "READEF.RJP" FOR OUTPUT AS #1
0A03    0220            PRINT #1,FILE$:                 'save filename in default file
0A13    0220            PRINT #1,MENU$(6,1):    'save the directory name as well
0A35    0220            CLOSE #1
0A3C    0220            RETURN
0A40    0220
0A40    0220    SEARCH:
0A45    0220            OPEN "READIR.RJP" FOR INPUT AS #1
0A56    0220            INPUT #1,REANUM%:       'read number of patterns in dir
0A6B    0220            I% = 1:                         'set entry pointer
0A6F    0220
0A6F    0220    SLOOP:
0A74    0220            LINE INPUT #1,A$:       'read next pattern name from dir
0A81    0220            IF A$ = MENU$(6,1) THEN GOTO SEARCH.DONE:       'compare name with dir entry
0AA5    0220            I% = I% + 1
0AAE    0220            IF I% < (REANUM% + 1) THEN GOTO SLOOP:'check for done
0AC1    0220    SEARCH.DONE:
0AC6    0220            CLOSE #1
0ACD    0220            RETURN
0AD1    0220
0AD1    0220    T1D:            'return with no change to exit reagent calibrate
0AD6    0220            PRINT #3,"UH";
0AE6    0220            CLOSE #3:'      close com channel
0AEB    0220            RETURN
0AF1    0220
0AF1    0220    T2:             'process "+" key
0AF6    0220            IF MENU% > 5 THEN RETURN
0B05    0220            NEWTIME = TIMER
0B0F    0224            DELTATIME = NEWTIME - OLDTIME
0B1F    022C            OLDTIME = NEWTIME
0B29    022C            IF DELTATIME > 0.15 THEN MULT% = 1 ELSE MULT% = MULT% + 1
0B4B    022E            IF MULT% > 100 THEN MULT% = 100
0B5B    022E            MENU(MENU%,0) = MENU(MENU%,0) + MENU(MENU%,3) * MULT%:  'add increment
0B9F    022E            IF MENU(MENU%,0) > MENU(MENU%,1) THEN MENU(MENU%,0) = MENU(MENU%,1):    'check max value
0C06    022E            COLOR 15,1:GOSUB DISPMENU:RETURN:                       'show new value
0C1D    022E
0C1D    022E    T3:             'process "-" key
0C22    022E            IF MENU% > 5 THEN RETURN
0C31    022E            NEWTIME = TIMER
```

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Reagent Jet Printer                                                                    PAGE  6
Reagent Calibration                                                                    07-14-86
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Offset  Data    Source Line                                  IBM Personal Computer BASIC Compiler V2.00

0C3B    022E            DELTATIME = NEWTIME - OLDTIME
0C4B    022E            OLDTIME = NEWTIME
0C55    022E            IF DELTATIME > 0.15 THEN MULTI = 1 ELSE MULTI = MULTI + 1
0C77    022E            IF MULTI > 100 THEN MULTI = 100
0C89    022E            MENU(MENUI,0) = MENU(MENUI,0) - MENU(MENUI,3) * MULTI:  'sub increment
0CCB    022E            IF MENU(MENUI,0) < MENU(MENUI,2) THEN MENU(MENUI,0) = MENU(MENUI,2):    'check min value
0D32    022E            COLOR 15,1:GOSUB DISPMENU:RETURN:                       'show new value
0D49    022E
0D49    022E    T4:             'process up arrow key
0D4E    022E            IF MENUI MOD 6 = 0 THEN RETURN:                 'in top row already
0D63    022E            DIFFI = -1:GOSUB NEWMENU:RETURN:        'move pointer up one
0D74    0230
0D74    0230    T5:             'process down arrow key
0D79    0230            IF MENUI MOD 6 = 5 THEN RETURN:                 'in bottom row already
0DBF    0230            DIFFI = 1:GOSUB NEWMENU:RETURN:                 'move pointer down one
0DA0    0230
0DA0    0230    T6:             'process left arrow key
0DA5    0230            IF INT(MENUI / 6) = 0 THEN RETURN       'in left column already
0DC5    0230            DIFFI = -6:GOSUB NEWMENU:RETURN:        'move pointer one left
0DD6    0230
0DD6    0230    T7:             'process right arrow key
0DDB    0230            IF INT(MENUI / 6) = 2 THEN RETURN       'in right column already
0DFE    0230            DIFFI = 6:GOSUB NEWMENU:RETURN:                 'move pointer one right
0E0F    0230
0E0F    0230    T8:             'input keys into KEYBUF$ until (cr) is entered
0E14    0230            IF MENUI > 10 THEN RETURN
0E23    0230            LOCATE 25,30:COLOR 31,0:PRINT "ENTER NEW VALUE";:COLOR 15,0
0E55    0230            KEYBUF$ = A$
0E5F    0234            WHILE A$ <> CHR$(13)
0E72    0234                    LOCATE 25,47:PRINT SPACE$(15);
0E8F    0234                    LOCATE 25,47:PRINT KEYBUF$;
0EA9    0234                    A$ = ""
0EB3    0234                    WHILE A$ = ""
0EC2    0234                            A$ = INKEY$
0ECC    0234                            IF ACTIVE% = 1 AND DOWNTIME < TIMER THEN GOSUB PEN.DOWN
0EF6    0234                    WEND
0EF9    0234                    IF A$ = CHR$(8) AND LEN(KEYBUF$) > 0 THEN KEYBUF$ = LEFT$(KEYBUF$,LEN(KEYBUF$)-1)
0F3B    0234                    IF A$ > CHR$(31) AND LEN(KEYBUF$) < 15 THEN KEYBUF$ = KEYBUF$ + A$
0F75    0234            WEND
0F79    0234
0F79    0234            IF MENUI > 5 THEN GOTO STORESTRING
0F8B    0234
0F8B    0234            TEMP = VAL(KEYBUF$)     'temp has value of keys input
0F9B    0238
0F9B    0238            'round off temp according to step size in menu array
0F9B    0238            TEMP = INT(TEMP / (MENU(MENUI,3)) + .5) * MENU(MENUI,3)
0FD1    0238
0FD1    0238            'test TEMP for maximum and minimum values in menu array
0FD1    0238            IF TEMP > MENU(MENUI,1) THEN TEMP = MENU(MENUI,1)
1019    0238            IF TEMP < MENU(MENUI,2) THEN TEMP = MENU(MENUI,2)
104F    0238
104F    0238            'insert new value into menu array and update screen
104F    0238            MENU(MENUI,0) = TEMP
106B    0238            LOCATE 25,30:PRINT SPACE$(40);
```

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Reagent Jet Printer                                                    PAGE  7
Reagent Calibration                                                    07-14-86
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Offset  Data    Source Line                    IBM Personal Computer BASIC Compiler V2.00

1088    023B            COLOR 0,7:GOSUB DISPMENU
109A    023B            RETURN
109E    023B
109E    023B    STORESTRING:
10A3    023B            MENU$(MENUZ,1) = KEYBUF$
10BF    023B            LOCATE 25,30:PRINT SPACE$(40);
10DC    023B            COLOR 0,7:GOSUB DISPMENU
10EE    023B            RETURN
10F2    023B
10F2    023B    PEN.DOWN:
10F7    023B            DOWNTIME = TIMER + 1
1107    023B            PRINT #3,"D";
1117    023B            RETURN
111B    023B
111B    023B    ANYKEY:
1120    023B            LOCATE 25,64:PRINT "Strike any key..";
113A    023B            A$ = ""
1144    023B            WHILE A$ = ""
1153    023B                  A$ = INKEY$
115D    023B            WEND
1160    023B            LOCATE 25,1:COLOR 15,0:PRINT SPACE$(79);:COLOR 15,1
1196    023B            RETURN
119A    023B
119A    023B    NEWMENU: 'write old item in yellow, point to and highlight new item
119F    023B            COLOR 14,0:GOSUB DISPMENU
11B1    023B            MENUZ = MENUZ + DIFFZ
11BD    023B            IF MENUZ = 11 THEN MENUZ = 10
11CF    023B            IF MENUZ > 15 THEN MENUZ = 15
11E1    023B            COLOR 0,7:GOSUB DISPMENU:RETURN
11F7    023B
11F7    023B    INITIALIZE:
11FC    023B            'change to second screen and display messages
11FC    023B            SCREEN 0,0,1,1:COLOR 7,0:CLS:LOCATE 10,28:PRINT "Initializing Menu Display";
1240    023B            LOCATE 12,33:PRINT "Please Wait..."
125A    023B
125A    023B            'initialize variables
125A    023B
125A    023B            ACTIVEZ = 0:'   not printing
1261    023B
1261    023B            'initialize plotter com channel
1261    023B
1261    023B            OPEN "COM1:2400,N,8,2" AS #3
1273    023B            PRINT #3,";:UEC5,EFV1,H";
1283    023B
1283    023B            'initialize digital port
1283    023B            SCRZ = 4
128A    023A            CALL DIGITAL.OUT(SCRZ)
129A    023A            SCRZ = 0
12A1    023A            CALL DIGITAL.OUT(SCRZ):         'pulse reset line to set amplitude to 0V.
12B1    023A            SCRZ = 4
12B8    023A            CALL DIGITAL.OUT(SCRZ)
12C8    023A
12C8    023A            'set hardware pulse width
12C8    023A            CALL SET.DOT.WIDTH(5)   'in module PCI
```

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Reagent Jet Printer                                                                    PAGE  8
Reagent Calibration                                                                    07-14-86
                                                                                       12:26:57
Offset- Data    Source Line                                  IBM Personal Computer BASIC Compiler V2.00

 12DE   023C
 12DE   023C          'initialize menu arrays
 12DE   023C          RESTORE ARRDATA
 12E3   023C          FOR IZ=0 TO 17
 12EB   023C                READ MENU$(IZ,0),MENU$(IZ,1):
 131B   023C                READ MENU(IZ,1),MENU(IZ,2),MENU(IZ,3),MENU(IZ,4)
 137C   023C          NEXT IZ
 138F   023C
 138F   023C          'set default reagent values
 138F   023C
 138F   023C          MENU(0,0) = 2000:           'frequency
 13AB   023C          MENU(1,0) = 0:              'amplitude
 13C4   023C          MENU(2,0) = 1:              'strobe delay
 13E0   023C          MENU(3,0) = 090:            'pulse width
 13FC   023C          MENU(4,0) = 470:            'rise time
 1418   023C          MENU(5,0) = 070:            'fall time
 1436   023C
 1436   023C          MENU(6,0) = 0:              'name
 1452   023C          MENU(7,0) = 0:              'concentration
 146E   023C          MENU(8,0) = 0:              'density
 148A   023C          MENU(9,0) = 0:              'viscosity
 14A6   023C          MENU(10,0) = 0:                    'surface tension
 14C2   023C
 14C2   023C          OLD.AMP.VALUE1 = 0          'initial value of 0 volts
 14C9   023E
 14C9   023E          'change active displayed screen to first screen to draw and display parameters
 14C9   023E
 14C9   023E          SCREEN 0,0,0,1:CLS
 14E6   023E
 14E6   023E          COLOR 13:LOCATE 1,32:PRINT "REAGENT CALIBRATE";
 1507   023E          COLOR 9
 150E   023E          FOR I=2 TO 79
 1518   023E                LOCATE 3,I:PRINT "D";:LOCATE 5,I:PRINT "D";:LOCATE 19,I:PRINT "D";
 156F   023E          NEXT I
 158A   023E          FOR I=4 TO 18
 1594   023E                LOCATE I,1:PRINT "3";:LOCATE I,28:PRINT ":";:LOCATE I,69:PRINT ":";:LOCATE I,80:PRINT "3";
 1608   023E          NEXT I
 1626   023E          RESTORE TABLE
 1629   023E          FOR I=1 TO 12
 1637   023E                READ RI,CI,NI:LOCATE RI,CI:PRINT CHR$(NI);
 166A   0244          NEXT I
 1685   0244
 1685   0244          'print three headings and instructions
 1685   0244          COLOR 10,0
 1691   0244          LOCATE 4,7:PRINT "DROP PARAMETERS";
 16A1   0244          LOCATE 4,39:PRINT "REAGENT PARAMETERS"
 16C5   0244          LOCATE 4,71:PRINT "COMMANDS";
 16DF   0244
 16DF   0244          COLOR 7:LOCATE 21,20:PRINT "Use ";:COLOR 15:PRINT CHR$(27):CHR$(32);CHR$(26);
 1729   0244          PRINT CHR$(32);CHR$(24);CHR$(32);CHR$(25);:COLOR 7:PRINT " to position highlighted cursor";
 1768   0244          LOCATE 22,18:PRINT "Use ";:COLOR 15:PRINT "+";:COLOR 7:PRINT " or ";:COLOR 15:PRINT "-";
 17BE   0244          COLOR 7:PRINT" to scroll current value up or down";
 1702   0244          LOCATE 23,26:PRINT "Use ";:COLOR 15:PRINT "DY";:COLOR 7:PRINT" to activate selection";
 1814   0244
```

```
Offset  Data    Source Line
 1814   0244    DISP.PARMS:
 1819   0244            'display 18 menu choices in yellow
 1819   0244
 1819   0244            COLOR 14,0
 1825   0244            FOR MENUZ = 0 TO 17
 1829   0244                    GOSUB DISPMENU
 1831   0244            NEXT MENUZ
 1841   0244
 1841   0244            'set for reagent name and highlight it
 1841   0244            MENUZ = 6:COLOR 0,7
 1854   0244            GOSUB DISPMENU
 185A   0244
 185A   0244            SCREEN 0,0,0,0
 186F   0244            RETURN
 1873   0244    REM $PAGE
```

```
Reagent Jet Printer                                                                    PAGE 10
Reagent Calibration                                                                    07-14-86
                                                                                       12:26:57
Offset  Data    Source Line                                  IBM Personal Computer BASIC Compiler V2.00

 1873   0244    DISPMENU:
 1878   0244            LOCATE (MENUX MOD 6)*2+7,(INT(MENUX/6)*28+2)+15*INT(MENUX/12)
 18D4   0244            PRINT MENU$(MENUX,0)
 18F2   0244            IF MENUX > 5 THEN GOTO SHOWSTRING:'     no value to display
 1901   0244            LOCATE (MENUX MOD 6)*2+7,MENU(MENUX,4)
 1933   0244            PRINT USING MENU$(MENUX,1);MENU(MENUX,0);
 1966   0244            IF MENUX > 2 THEN RETURN
 1975   0244            ON MENUX+1 GOSUB SET.FREQ, SET.AMP, SET.DELAY
 1986   0244            RETURN
 198A   0244    SHOWSTRING:
 198F   0244            IF MENUX > 10 THEN RETURN
 199E   0244            LOCATE (MENUX MOD 6)*2+7,48
 19BA   0244            PRINT *                 *
 19C7   0244            LOCATE (MENUX MOD 6)*2+7,48
 19E3   0244            PRINT MENU$(MENUX,1)
 1A02   0244            RETURN
 1A06   0244
 1A06   0244    SET.FREQ:
 1A0B   0244            TEMP = MENU(0,0)
 1A24   0244            CALL SET.DOT.RATE(TEMP):        'in module PCI
 1A34   0244            LEDI = 3-INT((TEMP+500)/1000)
 1A57   0246            IF LEDI < 0 THEN LEDI = 0
 1A69   0246            SCRI = 4 + (LEDI * 32):                 'set LED intensity
 1A89   0246            CALL DIGITAL.OUT(SCRI):                 'in module PCI
 1A99   0246            RETURN
 1A9D   0246
 1A9D   0246    SET.AMP:
 1AA2   0246            SCRI = CINT(MENU(MENUX,0) * 255 / 150):         'convert volts to binary number
 1ACB   0246            IF SCRI = OLD.AMP.VALUEI THEN RETURN
 1ADC   0246            TEMPI = SCRI - OLD.AMP.VALUEI:          'calculate delta
 1AEB   0248            OLD.AMP.VALUEI = SCRI:                  'update old value to current value
 1AEF   0248            DIG.VALI = 6
 1AF6   024A            IF TEMPI < 0 THEN DIG.VALI = 5
 1B0B   024A            TEMPI = ABS(TEMPI)
 1B15   024A            FOR II = 1 TO TEMPI
 1B22   024C                    SCRI = DIG.VALI + (32*LEDI)
 1B3F   024C                    CALL DIGITAL.OUT(SCRI):                 'pulse higher or lower
 1B4F   024C                    SCRI = 4 + (32 * LEDI)
 1B6F   024C                    CALL DIGITAL.OUT(SCRI):                 'set port to normal
 1B7F   024C            NEXT II
 1B91   024C            RETURN
 1B95   024C
 1B95   024C    SET.DELAY:
 1B9A   024C            TEMP = MENU(2,0)
 1BB6   024C            CALL SET.STROBE.DELAY(TEMP):    'in module PCI
 1BC6   024C            RETURN
 1BCA   024C
 1BCA   024C    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  11
Reagent Calibration                                                    07-14-86
                                                                       12:26:57
Offset  Data    Source Line                    IBM Personal Computer BASIC Compiler V2.00

 1BCA   024C    '************ DATA USED BY THIS MODULE ************
 1BCA   024C
 1BCA   024C    ARRDATA:
 1BCF   024C            DATA "Frequency              Hz","##,###",10000,1,1,16
 1BD1   024C            DATA "Amplitude              V ","###",150,0,1,19
 1BD3   024C            DATA "Strobe Delay           uS","##,###.#",15999.5,.5,.5,16
 1BD5   024C            DATA "Pulse Width              ","###",999,0,1,19
 1BD7   024C            DATA "Rise Time                ","###",999,0,1,19
 1BD9   024C            DATA "Fall Time                ","###",999,0,1,19
 1BDB   024C            DATA "Name","",0,0,0,0
 1BDD   024C            DATA "Concentration","",0,0,0,0
 1BDF   024C            DATA "Density","",0,0,0,0
 1BE1   024C            DATA "Viscosity","",0,0,0,0
 1BE3   024C            DATA "Surface Tension","",0,0,0,0
 1BE5   024C            DATA "","",0,0,0,0
 1BE7   024C            DATA "START","",0,0,0,0
 1BE9   024C            DATA "LOAD","",0,0,0,0
 1BEB   024C            DATA "SAVE","",0,0,0,0
 1BED   024C            DATA "EXIT","",0,0,0,0
 1BEF   024C            DATA "","",0,0,0,0
 1BF1   024C            DATA "","",0,0,0,0
 1BF3   024C
 1BF3   024C    TABLE:
 1BF8   024C            DATA 3,1,218
 1BFA   024C            DATA 3,28,210
 1BFC   024C            DATA 3,69,210
 1BFE   024C            DATA 3,80,191
 1C00   024C            DATA 5,1,198
 1C02   024C            DATA 5,28,206
 1C04   024C            DATA 5,69,206
 1C06   024C            DATA 5,80,181
 1C08   024C            DATA 19,1,192
 1C0A   024C            DATA 19,28,208
 1C0C   024C            DATA 19,69,208
 1C0E   024C            DATA 19,80,217
 1C10   024C
 1C10   024C    END SUB
 1C17   024C
 1C17   024C
 23E8-  024C

50426 Bytes Available
43960 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

```
Reagent Jet Printer                                                    PAGE  1
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

0030  0006  REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Pattern Entry/Modif
            ication'
0030  0006  'MODULE   - "PATENT" Pattern creation, modification, and filing
            .
0030  0006  '
0030  0006  'AUTHOR   - N. A. Enevold
0030  0006  '
0030  0006  'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030  0006  '
0030  0006  'REVISION - 1.2 03-10-86 NAE Remove Mouse inputs
0030  0006  '            1.1 02-20-86 NAE Add 80 pattern limit to save
0030  0006  '            1.0 01-13-86 NAE Creation of initial code
0030  0006  '
0030  0006  'SYSTEM   - This code can only be compiled by the BASCOM
0030  0006  '            COMPILER, it will not run under the INTERPRETER!!
0030  0006  '
0030  0006  'DESCRIPTION:
0030  0006  '       This module allows the user to LOAD, SAVE, DIRectory, D
            RAW and
0030  0006  '       enter repeat count and other parameters for a pattern t
            o be printed.
0030  0006  '       The low-resolution graphics mode is selected and a menu
             is displayed
0030  0006  '       across the bottom of the screen.  Using arrow keys
0030  0006  '       point to the action to be taken and then invoke that ac
            tion with the
0030  0006  '       Enter key.  In the DRAW mode, another menu is
0030  0006  '       displayed which allows the user to select from LINE, RE
            CTangle,
0030  0006  '       Solid RECTangle, or CIRCLe pattern elements.
0030  0006  '
0030  0006  'DATA DICTIONARY
0030  0006  '       SCNDAT%(50,5)     51 Row (Elements) by 6 Colum array f
            or storing pattern elements
0030  0006  '       CURSOR%(9)        Storage for cursor graphics icon
0030  0006  '       MENU$(6)          Up to 7 menu names can be saved here
0030  0006  '       ELNUM%            Count of number of elements in a patt
            ern
0030  0006  '       X%  Y%            Current location of graphics cursor
0030  0006  '       GRID              Value of one dot space on the screen
            (default is 0.005")
0030  0006  '       ROW%  COL%        Location to print instructions
0030  0006  '       A$                Storage for single key-strokes or inp
            ut strings
0030  0006  '       MENUNUM           Which menu is being displayed (1 or 2
            )
0030  0006  '       ITEM              Pointer to which menu item is highlig
            hted (0 - 6)
0030  0006  '       REPEAT%           Number of times pattern is to be repe
            ated when printed
0030  0006  '       XOFF  YOFF        X and Y axis distance between the pri
            nting of repeated patterns
0030  0006  '       ROWSP COLSP       Row and Column spacing for printing m
            ultiple sets of patterns
```

```
Reagent Jet Printer                                                    PAGE  2
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    '       PATNUM%                 Number of patterns stored in
                the pattern directory PATDIR.RJP
 0030   0006    '       DROW%  DCOL%    Row and Column location to display di
                rectory entrys
 0030   0006    '       NAME$           Pattern name to be LOADed or SAVEd to
                 directory
 0030   0006    '       I%  J%          Counters used to LOAD or SAVE the ele
                ment data from/to pattern data file
 0030   0006    '       FILE$           Name of pattern data file
 0030   0006    '       TEMP%           Which type of element is being drawn.
                  1 = Line   2 = Rectangle
 0030   0006    '
                 3 = Solid Rectangle  4 = Circle
 0030   0006    '       FLAG%           Same as TEMP% above
 0030   0006    '       STARTMSG$ ENDMSG$ Message display for startpoint and en
                dpoint of element entry
 0030   0006    '       X1% Y1%                 Starting cursor position for
                element being drawn
 0030   0006    '       DX% DY%                 Delta X and Y values used to
                re-position cursor after arrow key
 0030   0006    '       MAXITEM                 The highest number item in th
                e current menu display
 0030   0006    '       XS  XE          Starting and ending X position of the
                 menu highlighting blue box
 0030   0006    '       RADIUS%                 The calculated radius of a ci
                rcle to be displayed
 0030   0006    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  3
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    SUB PATENTRY STATIC
 0047   0006
 0047   0006            WIDTH 40:SCREEN 1:CLS
 005F   0006            DIM SCRDATZ(50,5),CURSORZ(9),MENU$(6)
 0060   029A            ELNUMZ = 0:XZ=0:YZ=0:GRID = 0.005
 007F   02A4
 007F   02A4            LINE (0,0)-(6,6),,B
 00A1   02A4            LINE (0,3)-(6,3),,B
 00C5   02A4            LINE (3,0)-(3,6),,B
 00E9   02A4            PRESET (3,3)
 00F5   02A4            GET (0,0)-(6,6),CURSORZ
 0116   02A4            CLS
 011D   02A4
 011D   02A4            LINE (0,0)-(319,190),,B
 0140   02A4
 0140   02A4            RESTORE INSTRUC
 0147   02A4            FOR I=1 TO 4
 0151   02A4                    READ ROWZ,COLZ,A$
 0164   02AC                    LOCATE ROWZ,COLZ:PRINT A$;
 01B0   02AC            NEXT I
 019B   02B0
 019B   02B0    FIRST:
 01A0   02B0            MENUNUM = 1
 01AA   02B4            GOSUB SUBMENU
 01B0   02B4
 01B0   02B4            ON ITEM + 1 GOTO PATDIR, PATLOAD, PATSAVE, PATDRAW, REP
                EAT, PATEXT
 01CD   02B8            GOTO FIRST
 01D0   02B8
 01D0   02B8    REPEAT:
 01D5   02B8            GOSUB ITEMBOXERASE:     'erase blue box around DIR
 01DB   02B8            LOCATE 25,1:PRINT SPACE$(39);   'erase menu line
 01F8   02B8            LOCATE 25,1:INPUT;"Enter Repeat Count  ",REPEATZ
 021B   02BA            LOCATE 25,1:PRINT SPACE$(39);   'erase menu line
 0235   02BA            LOCATE 25,1:INPUT;"Enter X Axis Offset ",XOFF
 0255   02BE            LOCATE 25,1:PRINT SPACE$(39);   'erase menu line
 0272   02BE            LOCATE 25,1:INPUT;"Enter Y Axis Offset ",YOFF
 0292   02C2            GOTO FIRST
 0296   02C2    PATEXIT:
 029B   02C2            WIDTH 80:SCREEN 0:CLS
 02B2   02C2            EXIT SUB
 02B6   02C2    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  4
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Cosputer BASIC Cospiler V2.00

 02B6   02C2    PATDIR:                  'list directory of patterns
 02BB   02C2            GOSUB ITEMBOXERASE:     'erase blue box around DIR
 02C1   02C2            LOCATE 25,1:PRINT SPACE$(39);   'erase menu line
 02DE   02C2            OPEN "PATDIR.RJP" FOR INPUT AS #1:      'open directory
                         file
 02EF   02C2            INPUT #1, PATNUM%:      'read number of patterns in dir
                        ectory
 0301   02C4            LINE (1,1)-(318,189),0,BF:      'erase graphics tablet
 0326   02C4            I = 0:                          'set counter
 0330   02C4
 0330   02C4    DISLOOP:
 0335   02C4            I = I + 1:              'set for next value
 0344   02C4            IF I > PATNUM% THEN GOTO DIREXIT:       'test for done
 035B   02C4            IF INT((I-1)/44) <> (I-1)/44 THEN GOTO SHOWNEXT
 0384   02C4            IF INT((I-1)/44) < 1 THEN GOTO SHOWNEXT
 03A9   02C4
 03A9   02C4            LOCATE 25,1:PRINT "More to Display. Continue ? (Y or N)
                        ";
 03C3   02C4            GOSUB CORLOOP:  'wait for Y or N response
 03C9   02C4            IF A$ = "N" THEN GOTO DIREXIT:  'if N then don't contin
                        ue
 03DC   02C4
 03DC   02C4            LINE (1,1)-(318,189),0,BF:      'erase graphics tablet
 0401   02C4
 0401   02C4    SHOWNEXT:
 0406   02C4            DROW% = ((I - 1) MOD 22) + 2:   'calculate row for disp
                        lay
 0422   02C6            DCOL% = 4:                      'set coluan to 4
 0429   02C8            IF ((I - 1) MOD 44) > 21 THEN DCOL% = 23:'reset coluan
                        if necessary
 044C   02C8
 044C   02C8            LINE INPUT #1, A$:      'read next name from directory
 0459   02C8            LOCATE DROW%,DCOL%:PRINT A$;    'PRINT NAME
 0475   02C8            GOTO DISLOOP
 0479   02C8
 0479   02C8    DIREXIT:
 047E   02C8            CLOSE #1:       'terminate access to PATDIR.RJP
 0485   02C8            GOTO FIRST
 0489   02C8
 0489   02C8    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  5
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0489   02C3    PATLOAD:
 048E   02C3            GOSUB ITEMBOXERASE:     'erase blue box around DIR
 0494   02C8            OPEN "PATDIR.RJP" FOR INPUT AS #1
 04A5   02C8            INPUT #1,PATNUM%:       'read number of patterns in dir
 0487   02C9            GOSUB GETNAME:          'prompt for and input pattern n
                ame
 04BD   02C9            LINE (1,1)-(318,189),0,BF:      'erase graphics tablet
 04E2   02C8
 04E2   02C8            GOSUB SEARCH
 04E8   02C8
 04E8   02C8            IF I% < (PATNUM% + 1) THEN GOTO FOUND
 04FC   02C8            LOCATE 10,16-(LEN(NAME$)/2):PRINT NAME$;" not Found";
 0531   02CE            LOCATE 12,14:PRINT "Strike Any Key"
 054B   02CE            GOSUB ANYKEY:   'wait for a keyhit
 0551   02CE            GOTO FIRST
 0555   02CE
 0555   02CE    FOUND:
 055A   02CE            FILE$ = RIGHT$(STR$(I%),LEN(STR$(I%))-1) + "PAT.RJP"
 057E   02D2            OPEN FILE$ FOR INPUT AS #1:     'set pattern data file
                for read
 058F   02D2            INPUT #1,ELNUM%:        'read number of elements in pat
                tern
 05A1   02D2            INPUT #1,GRID:          'read grid size
 05B3   02D2            INPUT #1,REPEAT%:       'read repeat count
 05C5   02D2            INPUT #1,XOFF:          'read x axis offset for repeat
 05D7   02D2            INPUT #1,YOFF:          'read y axis offset for repeat
 05E9   02D2
 05E9   02D2            FOR I% = 0 TO ELNUM% - 1
 05F7   02D4                FOR J% = 0 TO 5
 05FD   02D4                    INPUT #1,SCRDATA%(I%,J%):'read file into screen
                array
 0621   02D6                NEXT J%
 0631   02D6            NEXT I%
 0643   02D6            CLOSE #1:       'done with data file
 064A   02D6
 064A   02D6            OPEN "PATDEF.RJP" FOR OUTPUT AS #1
 065C   02D6            PRINT #1,FILE$:                 'save filename in defau
                lt file
 066C   02D6            PRINT #1,NAME$:                 'save the directory nam
                e as well
 067C   02D6            CLOSE #1
 0683   02D6
 0683   02D6            GOTO REDRAW
 0687   02D6
 0687   02D6    SEARCH:
 068C   02D6            I% = 1:                         'set entry pointer
 0693   02D6    SLOOP:
 0698   02D6            LINE INPUT #1,A$:       'read next pattern name from di
                r
 06A5   02D6            IF A$ = NAME$ THEN GOTO SEARCH.END:     'compare name w
                ith dir entry
 06B8   02D6            I% = I% + 1
 06C1   02D6            IF I% < (PATNUM% + 1) THEN GOTO SLOOP:'check for done
 06D4   02D6    SEARCH.END:
```

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Reagent Jet Printer                                                    PAGE   6
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 06D9   02D6            CLOSE #1:       'not found so close file and display me
                       ssage
 06E0   02D6            RETURN
 06E4   02D6
 06E4   02D6    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 06E4   02D6    PATSAVE:
 06E9   02D6            GOSUB ITEMBOXERASE:     'erase blue box around DIR
 06EF   02D6            IF ELNUM% = 0 THEN GOTO FIRST:  'no elements in pattern
 06FE   02D6            OPEN "PATDIR.RJP" FOR INPUT AS #1
 070F   02D6            INPUT #1,PATNUM%
 0721   02D6            IF PATNUM% < 80 THEN GOTO SAVE.PAT:     'directory full
         at 80 patterns
 0730   02D6            CLOSE #1
 0737   02D6            LOCATE 25,1:PRINT SPACE$(39);:          'erase bottom l
        ine
 0754   02D6            LOCATE 25,1:PRINT "Directory is full (80 patterns max)"
        ;
 076E   02D6            GOSUB ANYKEY:GOTO FIRST
 077B   02D6    SAVE.PAT:
 077D   02D6            GOSUB GETNAME:  'prompt for and get pattern name
 0783   02D6            GOSUB SEARCH
 0789   02D6            IF I% > PATNUM% THEN GOTO ADD.NEW.PATTERN
 079A   02D6            LINE (1,1)-(318,189),0,BF:      'erase graphics tablet
 07BF   02D6            LOCATE 10,13-(LEN(NAME$)/2):PRINT NAME$;" already exist
        s.";
 07F4   02D6            LOCATE 12,15:PRINT "Replace it?"
 080E   02D6            PATNUM% = I%
 0815   02D6            A$ = ""
 081F   02D6            WHILE A$ = ""
 082E   02D6                    A$ = INKEY$
 0838   02D6            WEND
 083B   02D6            IF A$ = "Y" OR A$ = "y" THEN GOTO SAVE.PATTERN
 0864   02D6            GOTO FIRST
 0868   02D6
 0868   02D6    ADD.NEW.PATTERN:
 086D   02D6            KILL "PATDIR.OLD":      'delete old backup directory
 0874   02D6            NAME "PATDIR.RJP" AS "PATDIR.OLD":      'save old direc
        tory
 087E   02D6            OPEN "PATDIR.OLD" FOR INPUT AS #1
 088F   02D6            OPEN "PATDIR.RJP" FOR OUTPUT AS #2:     'set up new dir
 08A1   02D6            INPUT #1,PATNUM%:       'read number of dir entries
 08B3   02D6            PATNUM% = PATNUM% + 1:  'increase by 1
 08BC   02D6            WRITE #2,PATNUM%:       'save in new directory
 08CD   02D6            FOR I=1 TO PATNUM% - 1
 08E6   02DA                LINE INPUT #1,A$:   'read entry from old dir
 08F3   02DA                PRINT #2,A$:        'write entry in new directory
 0903   02DA            NEXT I
 091E   02DA            PRINT #2,NAME$:         'write new entry to new directo
        ry
 092E   02DA            CLOSE #1:CLOSE #2:      'done with directory
 093C   02DA    SAVE.PATTERN:
 0941   02DA            FILE$ = RIGHT$(STR$(PATNUM%),LEN(STR$(PATNUM%))-1) + "P
        AT.RJP"
 0965   02DA            OPEN FILE$ FOR OUTPUT AS #1:    'create new pattern dat
        a file
 0977   02DA            WRITE #1,ELNUM%:        'store number of elements
 0988   02DA            WRITE #1,GRID:          'store grid dimension
 0998   02DA            WRITE #1,REPEAT%:       'store repeat count
 09A9   02DA            WRITE #1,XOFF:          'store x axis offset for repeat
```

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Reagent Jet Printer                                                    PAGE   8
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 09B9   02DA            WRITE #1,YOFF:          'store y axis offset for repeat
 09C9   02DA            FOR IZ = 0 TO ELNUMZ - 1
 09D7   02DC                FOR JZ = 0 TO 5
 09DD   02EC                    WRITE #1,SCNDATZ(IZ,JZ):        'write screen a
                rray to file
 0A00   02EC                NEXT JZ
 0A10   02EC            NEXT IZ
 0A22   02DC            CLOSE #1:       'done with data file
 0A29   02DC            OPEN "PATDEF.RJP" FOR OUTPUT AS #1
 0A3B   02DC            PRINT #1,FILE$:                 'save filename in defau
                lt file
 0A4B   02DC            PRINT #1,NAME$:                 'save the directory nam
                e as well
 0A5B   02DC            CLOSE #1
 0A62   02DC            GOTO FIRST
 0A66   02DC    REM $PAGE
```

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Reagent Jet Printer                                                    PAGE  9
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0A6o   02DC    PATDRAW:
 0A6E   02DC            GOSUB ITEMSCREERASE
 0A71   02DC            LINE (1,1)-(318,189),0,BF:      'Erase graphics tablet
 0A96   02DC
 0A96   02DC    NEXTEL:
 0A9E   02DC            MENUNUM = 2
 0AA5   02DC            GOSUB SUBMENU
 0AAB   02DC
 0AAB   02DC            ON ITEM + 1 GOTO ALINE, RECT, SRECT, ACIRCLE, REDRAW, B
                ACKUP
 0AC8   02DC            GOTO NEXTEL
 0ACB   02DC
 0ACB   02DC    BACKUP:
 0AD0   02DC            GOSUB ITEMBOXERASE
 0AD6   02DC            GOTO FIRST
 0ADA   02DC
 0ADA   02DC    ALINE:
 0ADF   02DC            TEMP% = 1
 0AE6   02DE            STARTMSG$ = "STARTING ENDPOINT"
 0AF0   02E2            ENDMSG$ = "ENDING ENDPOINT  "
 0AFA   02E6            GOTO ENTERELEMENT
 0AFE   02E6
 0AFE   02E6    RECT:
 0B03   02E6            TEMP% = 2
 0B0A   02E6            GOTO RECTMSG
 0B0E   02E6
 0B0E   02E6    SRECT:
 0B13   02E6            TEMP% = 3
 0B1A   02E6    RECTMSG:
 0B1F   02E6            STARTMSG$ = "STARTING CORNER"
 0B29   02E6            ENDMSG$ = "ENDING CORNER  "
 0B33   02E6            GOTO ENTERELEMENT
 0B37   02E6
 0B37   02E6    ACIRCLE:
 0B3C   02E6            TEMP% = 4
 0B43   02E6            STARTMSG$ = "CENTER OF CIRCLE"
 0B4D   02E6            ENDMSG$ = "POINT ON CIRCLE "
 0B57   02E6
 0B57   02E6    ENTERELEMENT:
 0B5C   02E6            GOSUB ITEMBOXERASE
 0B62   02E6            FLAG%=0
 0B69   02E8            LOCATE 25,1:PRINT SPACE$(39);
 0B86   02E8            LOCATE 25,1:PRINT STARTMSG$;
 0BA0   02E8            GOSUB DISPCURSOR
 0BA6   02E8    FINDSTART:
 0BAB   02E8            GOSUB MOUSEACT
 0BB1   02E8            IF A$ = CHR$(27) THEN GOTO ABORT
 0BC8   02E8            IF A$ = CHR$(13) THEN GOTO SETSTART
 0BDF   02E8            GOSUB CURSORMOVE
 0BE5   02E8            GOTO FINDSTART
 0BE8   02E8    ABORT:
 0BED   02E8            GOSUB PLACECURSOR
 0BF3   02E8            GOTO NEXTEL
 0BF7   02E8
```

```
Reagent Jet Printer                                                    PAGE  10
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0BF7   02EB    SETSTART:
 0BFC   02EB            LOCATE 25,1:PRINT ENDMSG$;
 0C16   02EB            FLAGZ = TEMPZ:X1Z = XZ:Y1Z = YZ
 0C2B   02EC            IF FLAGZ = 4 THEN PSET (XZ+4,YZ+4)
 0C55   02EC    FINDEND:
 0C5A   02EC            GOSUB MOUSEACT
 0C60   02EC            IF A$ = CHR$(27) THEN GOTO CANCELEL
 0C77   02EC            IF A$ = CHR$(13) THEN GOTO SAVEEL
 0C8E   02EC            GOSUB CURSORMOVE
 0C94   02EC            GOTO FINDEND
 0C97   02EC    CANCELEL:
 0C9C   02EC            GOSUB PLACECURSOR
 0CA2   02EC            ON FLAGZ GOSUB ER1, ER2, ER3, ER4
 0CB3   02EC            FLAGZ = 0
 0CBA   02EC            GOTO NEXTEL
 0CBE   02EC    SAVEEL:
 0CC3   02EC            GOSUB PLACECURSOR
 0CC9   02EC            IF FLAGZ = 4 THEN CIRCLE (X1Z+4,Y1Z+4),SQR((XZ-X1Z)^2+(
                YZ-Y1Z)^2),,,,1
 0D32   02EC            GOSUB CORRECT
 0D38   02EC            IF A$="N" THEN GOTO REDRAW
 0D4B   02EC    STOREEL:
 0D50   02EC            SCNDATZ(ELNUMZ,0) = FLAGZ
 0D6A   02EC            SCNDATZ(ELNUMZ,1) = X1Z
 0D85   02EC            SCNDATZ(ELNUMZ,2) = Y1Z
 0DA0   02EC            SCNDATZ(ELNUMZ,3) = XZ
 0DBB   02EC            SCNDATZ(ELNUMZ,4) = YZ
 0DD6   02EC            SCNDATZ(ELNUMZ,5) = 0
 0DEF   02EC            ELNUMZ = ELNUMZ + 1
 0DF8   02EC            FLAGZ = 0
 0DFF   02EC            GOTO NEXTEL
 0E03   02EC    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

0E03    02EC    REDRAW:
0E08    02EC            GOSUB ITEMBOXERASE
0E0E    02EC            LINE(1,1)-(318,189),0,BF
0E33    02EC            IF ELNUM% = 0 THEN GOTO NEXTEL
0E42    02EC
0E42    02EC            FOR I=0 TO ELNUM%-1
0E5B    02F0                    ON SCNDAT%(I,0) GOSUB RD1, RD2, RD3, RD4
0E81    02F0            NEXT I
0E9C    02F0            GOTO NEXTEL
0EA0    02F0
0EA0    02F0    '******** Sub-routines called by main module ********
0EA0    02F0
0EA0    02F0    SUBMENU:
0EA5    02F0
0EA5    02F0            LOCATE 25,1:PRINT SPACE$(39);
0EC2    02F0            ON MENUNUM GOSUB MENU1, MENU2
0ED1    02F0
0ED1    02F0            FOR I=0 TO 6
0EDB    02F0                    READ MENU$(I)
0EF2    02F0                    LOCATE 25,(I*6)+2:PRINT MENU$(I);
0F2B    02F0            NEXT I
0F46    02F0
0F46    02F0            READ MAXITEM
0F4D    02F4            ITEM = 0
0F57    02F4
0F57    02F4    NEWITEM:
0F5C    02F4            GOSUB NEWITEMBOX
0F62    02F4
0F62    02F4    NEXTITEM:
0F67    02F4            GOSUB ITEMSEARCH
0F6D    02F4            IF A$ = CHR$(13) THEN RETURN:'  ITEM has correct value
0F84    02F4            IF LEN(A$) < 2 THEN BEEP:GOTO NEXTITEM
0F9A    02F4            IF ASC(MID$(A$,2,1)) = 75 THEN GOTO LEFTAR
0FB6    02F4            IF ASC(MID$(A$,2,1)) = 77 THEN GOTO RIGHTAR
0FD2    02F4            BEEP:GOTO NEXTITEM
0FD9    02F4
0FD9    02F4    LEFTAR:
0FDE    02F4            IF ITEM = 0 THEN GOTO NEXTITEM
0FEE    02F4            GOSUB ITEMBOXERASE
0FF4    02F4            ITEM = ITEM - 1
1003    02F4            GOTO NEWITEM
1007    02F4
1007    02F4    RIGHTAR:
100C    02F4            IF ITEM = MAXITEM THEN GOTO NEXTITEM
101F    02F4            GOSUB ITEMBOXERASE
1025    02F4            ITEM = ITEM + 1
1034    02F4            GOTO NEWITEM
1038    02F4
1038    02F4    MENU1:
103D    02F4            RESTORE MN1
1044    02F4            RETURN
1048    02F4
1048    02F4    MENU2:
104D    02F4            RESTORE MN2
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 1054   02F4            RETURN
 1058   02F4
 1058   02F4    ITEMSEARCH:
 105D   02F4            A$ = INKEY$:IF A$ <> "" THEN RETURN
 107A   02F4            GOTO ITEMSEARCH
 107D   02F4            RETURN
 1081   02F4
 1081   02F4    NEWITEMBOX:
 1086   02F4            XS = (ITEM*48) + 7
 109C   02F8            XE = (ITEM*48) + 8 + LEN(MENU$(ITEM))*8
 10D9   02FC            LINE (XS,191)-(XE,199),1,B
 1101   02FC            RETURN
 1105   02FC
 1105   02FC    ITEMBOXERASE:
 110A   02FC            LINE (XS,191)-(XE,199),0,B
 1131   02FC            RETURN
 1135   02FC
 1135   02FC    PLACECURSOR:
 113A   02FC            PUT (X%+1,Y%+1),CURSOR%
 1157   02FC            RETURN
 115B   02FC
 115B   02FC    MOUSEACT:
 1160   02FC            GOSUB ANYKEY
 1166   02FC            DX% = 0 : DY% = 0
 1174   0300            IF A$ = CHR$(0) + CHR$(72) THEN DY% = -1:RETURN
 119D   0300            IF A$ = CHR$(0) + CHR$(80) THEN DY% =  1:RETURN
 11C6   0300            IF A$ = CHR$(0) + CHR$(77) THEN DX% =  1:RETURN
 11EF   0300            IF A$ = CHR$(0) + CHR$(75) THEN DX% = -1:RETURN
 121B   0300            IF A$ = "8" THEN DY% = -20:RETURN
 1232   0300            IF A$ = "2" THEN DY% =  20:RETURN
 124C   0300            IF A$ = "4" THEN DX% = -20:RETURN
 1266   0300            IF A$ = "6" THEN DX% =  20:RETURN
 1280   0300            IF A$ = CHR$(27) THEN RETURN
 1297   0300            IF A$ = CHR$(13) THEN RETURN
 12AE   0300            GOTO MOUSEACT
 12B2   0300
 12B2   0300    CURSORMOVE:
 12B7   0300            GOSUB PLACECURSOR
 12BD   0300            ON FLAG% GOSUB ER1, ER2, ER3, ER4
 12CE   0300            X% = X% + DX% : Y% = Y% + DY%
 12E6   0300            IF X% < 0 THEN X% = 0
 12F8   0300            IF X% > 311 THEN X% = 311
 1308   0300            IF Y% < 0 THEN Y% = 0
 131D   0300            IF Y% > 182 THEN Y% = 182
 1330   0300            ON FLAG% GOSUB DR1, DR2, DR3, DR4
 1341   0300            GOSUB DISPCURSOR
 1347   0300            RETURN
 134B   0300
 134B   0300    CORRECT:
 1350   0300            LOCATE 25,1:PRINT SPACE$(39);
 136D   0300            LOCATE 25,1:PRINT "IS THIS CORRECT? (Y or N) ";
 1387   0300    CORLOOP:
 138C   0300            GOSUB ANYKEY
 1392   0300            IF A$ = "y" OR A$ = "Y" THEN A$ = "Y":GOTO COREXIT
```

```
Offset  Data    Source Line
 13C5   0300            IF A$ = "n" OR A$ = "N" THEN A$ = "N":GOTO COREXIT
 13F8   0300            GOTO CORLOOP
 13FB   0300    COREXIT:
 1400   0300            LOCATE 25,1:PRINT SPACE$(39);
 141D   0300            RETURN
 1421   0300
 1421   0300    DISPCURSOR:
 1426   0300            GOSUB PLACECURSOR
 142C   0300            LOCATE 25,27:PRINT USING "+#.###";XZ * GRID;
 1456   0300            PRINT ",";
 1463   0300            PRINT USING "+#.###";YZ * GRID;
 1480   0300            RETURN
 1484   0300
 1484   0300
 1484   0300    RD1:
 1489   0300            LINE(SCNDATZ(I,1)+4,SCNDATZ(I,2)+4)-(SCNDATZ(I,3)+4,SCN
                DATZ(I,4)+4)
 1522   0300            RETURN
 1526   0300
 1526   0300    RD2:
 152B   0300            LINE(SCNDATZ(I,1)+4,SCNDATZ(I,2)+4)-(SCNDATZ(I,3)+4,SCN
                DATZ(I,4)+4),,B
 15C4   0300            RETURN
 15C8   0300
 15C8   0300    RD3:
 15CD   0300            LINE(SCNDATZ(I,1)+4,SCNDATZ(I,2)+4)-(SCNDATZ(I,3)+4,SCN
                DATZ(I,4)+4),,BF
 1667   0300            RETURN
 166B   0300
 166B   0300    RD4:
 1670   0300            RADIUSZ = SQR((SCNDATZ(I,3)-SCNDATZ(I,1))^2 + (SCNDATZ(
                I,4)-SCNDATZ(I,2))^2)
 16FF   0302            CIRCLE (SCNDATZ(I,1)+4,SCNDATZ(I,2)+4),RADIUSZ,,,,1
 175D   0302            RETURN
 1761   0302
 1761   0302    DR1:
 1766   0302            LINE (X1Z+4,Y1Z+4)-(XZ+4,YZ+4)
 17AF   0302            RETURN
 17B3   0302
 17B3   0302    DR2:
 17B8   0302            LINE (X1Z+4,Y1Z+4)-(XZ+4,YZ+4),,B
 1801   0302            RETURN
 1805   0302
 1805   0302    DR3:
 180A   0302            LINE (X1Z+4,Y1Z+4)-(XZ+4,YZ+4),,BF
 1854   0302            RETURN
 1858   0302
 1858   0302    DR4:
 185D   0302            RETURN
 1861   0302
 1861   0302    ER1:
 1866   0302            LINE (X1Z+4,Y1Z+4)-(XZ+4,YZ+4),0
 18AF   0302            RETURN
 18B3   0302
```


BAD ORIGINAL

```
Reagent Jet Printer                                                    PAGE  14
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 18B3   0302    ER2:
 18B8   0302            LINE (X1%+4,Y1%+4)-(X%+4,Y%+4),0,B
 1901   0302            RETURN
 1905   0302
 1905   0302    ER3:
 190A   0302            LINE (X1%+4,Y1%+4)-(X%+4,Y%+4),0,BF
 1954   0302            RETURN
 1958   0302
 1959   0302    ER4:
 195D   0302            RETURN
 1961   0302
 1961   0302    ANYKEY:
 1966   0302            A$ = ""
 1970   0302            WHILE A$ = ""
 197F   0302                    A$ = INKEY$
 1989   0302            WEND
 198C   0302            RETURN
 1990   0302
 1990   0302    GETNAME:        'prompt for and get filename
 1995   0302            LOCATE 25,1:PRINT SPACE$(39);
 19B2   0302            LOCATE 25,38:PRINT "<<";:       'boundry chevron
 19CC   0302            LOCATE 25,1:PRINT "Enter Pattern Name    ";
 19E6   0302            LINE INPUT; "",NAME$
 19F4   0302            RETURN
 19FB   0302
 19FB   0302    ' Data fields used by this module
 19F8   0302
 19F8   0302    MN1:
 19FD   0302            DATA "DIR","LOAD","SAVE","DRAW","REPT","EXIT","",5
 19FF   0302
 19FF   0302    MN2:
 1A04   0302            DATA "LINE","RECT","FRECT","CIRCL","REDRW","MAIN","",5
 1A06   0302
 1A06   0302    INSTRUC:
 1A0B   0302            DATA 8,16,"USE ARROWS"
 1A0D   0302            DATA 10,9,"TO SELECT FROM THE MENU"
 1A0F   0302            DATA 14,12,"USE THE ENTER KEY"
 1A11   0302            DATA 16,10,"TO ACTIVATE SELECTION"
 1A13   0302
 1A13   0302    END SUB
 1A1A   0302
 21AF   0302

50426 Bytes Available
43373 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

```
Reagent Jet Printer                                                    PAGE  1
Burr-Brown PCI-20000 custom driver                                     06-30-86
                                                                       08:38:16
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

0030    0006    REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Burr-Brown PCI-2000
                0 custom driver'
0030    0006    'MODULE   - "PCI" Driver for the PCI-20000 I/O and PULSE cards
0030    0006    '
0030    0006    'AUTHOR   - M. S. Fairchild of Computing Architects Inc.
0030    0006    '                               113 Fairfield Way
0030    0006    '                               Bloomingdale, Il 60108
0030    0006    '                               312/980-6777
0030    0006    '
0030    0006    'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030    0006    '
0030    0006    'REVISION - 1.2 12-16-85 MSF Add digital I/O initalization, and
                 output routine
0030    0006    '
0030    0006    '         - 1.1 12-10-85 MSF Move counter module to position 2
0030    0006    '
0030    0006    '         - 1.0 11-22-85 MSF Creation of initial code
0030    0006    '
0030    0006    'SYSTEM   - This code can only be compiled by the BASCOM V2
0030    0006    '           COMPILER, it will not run under the INTERPRETER!!
0030    0006    '
0030    0006    'DESCRIPTION:
0030    0006    '               The PCI module is a group of routines used to a
                ccess
0030    0006    '       the BURR-Brown PCI-20000 board. The supplied software c
                auses
0030    0006    '       the Wordstar2000 software to malfunction and will not p
                rivide
0030    0006    '       explicit on, off functions for the counters.  Custom dr
                ivers
0030    0006    '       will be made to provide all of the desired functions.
0030    0006    '
0030    0006    '
0030    0006    '       Address         Register
0030    0006    '       &HC0000 Carrier I.D. / module present (R)
0030    0006    '       &HC0040 Module interrupt status (R)
0030    0006    '       &HC0080 Digital I/O port 0 (R/W)
0030    0006    '       &HC0081 Digital I/O port 1 (R/W)
0030    0006    '       &HC0082 Buffer direction and enable (R/W)
0030    0006    '       &HC0083 Control for ports 0 and 1 (W)
0030    0006    '       &HC00C0 Digital I/O port 2 (R/W)
0030    0006    '       &HC00C1 Digital I/O port 3 (R/W)
0030    0006    '       &HC00C3 Control for ports 2 and 3 (W)
0030    0006
0030    0006    '       &HC0200         Read module I.D. (1110 1010)
0030    0006    '       &HC0204         Rate generator low-order 16 bits (0)
0030    0006    '       &HC0205         Rate generator high-order 16 bits (1)
0030    0006    '       &HC0206         Counter 3 count register (2)
0030    0006    '       &HC0207         Rate generator/counter 3 control
0030    0006    '       &HC0208         Counter 0 count register (0)
0030    0006    '       &HC0209         Counter 1 count register (1)
0030    0006    '       &HC020A         Counter 2 count register (2)
0030    0006    '       &HC020B         Counter 0 - 2 control
0030    0006    '       &HC020C         Counter gate control (1 enables, 0 disa
```

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Reagent Jet Printer                                                    PAGE  2
Burr-Brown PCI-20000 custom driver                                     06-30-86
                                                                       08:38:16
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

                bles:
 0030   0006    '                    bit     function
 0030   0006    '                    0       Rate generator gate
 0030   0006    '                    1       Rate generator gate
 0030   0006    '                    2       Counter 0 gate
 0030   0006    '                    3       Counter 1 gate
 0030   0006    '                    4       Counter 2 gate
 0030   0006    '                    5       Counter 3 gate
 0030   0006    '                    6       Not used
 0030   0006    '                    7       Not used
 0030   0006    '
 0030   0006    '
 0030   0006    'DATA DICTIONARY
 0030   0006    '
 0030   0006    '       COUNT   - Divisor to 2Mhz rate to give desired frequenc
                y or time
 0030   0006    '       COUNTHZ         - High order 16 bits of a 32 bit diviso
                r
 0030   0006    '       COUNTLZ - Low order 16 bits of a 32 bit divisor
 0030   0006    '       LSBZ    - Lower 8 bits of a 16 bit divisor
 0030   0006    '       MSBZ    - Upper 8 bits of a 16 bit divisor
 0030   0006
 0030   0006    ' Main line code
 0030   0006    '       The main line code is never executed. It's sole purpose
                 it to
 0030   0006    ' declare shared the variables that will be used in the subrout
                ines
 0030   0006    ' so that they will all be defined and hold their values.
 0030   0006
 0030   0006    MAIN:_
 0030   0006            DIM SHARED COUNT,COUNTHZ,COUNTLZ,LSBZ,MSBZ
 0030   0006
 0030   0006    MAINLOOP:_
 0030   0006            GOTO MAINLOOP
 004C   0012
 004C   0012    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 004C   0012    'SUBROUTINE     - PCI.INIT
 004C   0012    '
 004C   0012    'DESCRIPTION:
 004C   0012    '       The PCI.INIT subroutine initalizes the PCI hardware.
 004C   0012
 004C   0012    SUB PCI.INIT STATIC
 0053   0012
 0053   0012            DEF SEG = &HC000: 'Point segment to PCI-20000 board
 005A   0012
 005A   0012            POKE &H020C,&H00: 'Disable all software enabled counter
                s
 0063   0012
 0063   0012    ' Configure rate generator to 2 Mhz
 0063   0012
 0063   0012            POKE &H0207,&H34: 'Set low rate counter to mode 2
 006D   0012            POKE &H0207,&H74: 'Set high rate counter to mode 2
 0077   0012            POKE &H0204,&H02: 'Load low rate counter with 16 bits o
                f 2
 0081   0012            POKE &H0204,&H00
 008A   0012            POKE &H0205,&H02: 'Load high rate counter with 16 bits
                of 2
 0094   0012            POKE &H0205,&H00
 009D   0012            POKE &H020C,&H03: 'Enable rate counters
 00A7   0012
 00A7   0012    ' Configure dot rate counters (default to 5 Khz)
 00A7   0012
 00A7   0012            POKE &H020B,&H34: 'Set low dot counter (0) to mode 2
 00B1   0012            POKE &H020B,&H74: 'Set high dot counter (1) to mode 2
 00BB   0012            POKE &H0208,&H04: 'Load low rate counter with 16 bits o
                f 4
 00C5   0012            POKE &H020B,&H00
 00CE   0012            POKE &H0209,&H64: 'Load high rate counter with 16 bits
                of 100
 00DB   0012            POKE &H0209,&H00
 00E1   0012
 00E1   0012    ' Configure dot pulse with one shot (default to 13 usec)
 00E1   0012
 00E1   0012            POKE &H020B,&HB2: 'Set dot pulse with oneshot (2) to mo
                de 1
 00EB   0012            POKE &H020A,&H1A: 'Load oneshot with 16 bits of 26
 00F5   0012            POKE &H020A,&H00
 00FE   0012
 00FE   0012    ' Configure shifted strobe pulse one shot (default to .5 usec)
 00FE   0012
 00FE   0012            POKE &H0207,&HB2: 'Set shifted strobe onshot (3) to mod
                e 1
 0108   0012            POKE &H0206,&H01: 'Load oneshot with 16 bits of 1
 0112   0012            POKE &H0206,&H00
 011B   0012
 011B   0012    ' Configure port 0 to output and port 1 to input
 011B   0012
 011B   0012            POKE &H0083,&H82: ' Set up I/O chip
 0125   0012            POKE &H0082,&H34: ' Set up direction and enable buffers
 012F   0012            POKE &H0080,&H00: ' Dissable print head
```

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Reagent Jet Printer                                                    PAGE  4
Burr-Brown PCI-20000 custom driver                                     06-30-86
                                                                       08:38:16
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0136   0012          END SUB
 013F   0012
 013F   0012    REM $PAGEIF:12
 013F   0012    'SUBROUTINE     - DOT.ON
 013F   0012    '
 013F   0012    'DESCRIPTION:
 013F   0012    '       The DOT.ON subroutine enables the dot frequency counter
                s.
 013F   0012
 013F   0012    SUB DOT.ON STATIC
 0146   0012
 0146   0012          POKE &H020C,&H0F: 'Enable dot counters and rate generat
                or
 0150   0012
 0150   0012          END SUB
 0157   0012
 0157   0012    REM $PAGEIF:12
 0157   0012    'SUBROUTINE     - DOT.OFF
 0157   0012    '
 0157   0012    'DESCRIPTION:
 0157   0012    '       The DOT.OFF subroutine disables the dot counters
 0157   0012
 0157   0012    SUB DOT.OFF STATIC
 015E   0012
 015E   0012          POKE &H020C,&H03: 'Disable dot counters and enable rate
                 generator
 0168   0012
 0168   0012          END SUB
 016F   0012
 016F   0012    REM $PAGEIF:49
```

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Reagent Jet Printer                                                    PAGE  5
Burr-Brown PCI-20000 custom driver                                     06-30-86
                                                                       08:38:16
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 016F   0012    'SUBROUTINE     - SET.DOT.RATE
 016F   0012    '
 016F   0012    'DESCRIPTION:
 016F   0012    '       The SET.DOT.RATE subroutine loads the dot rate counters
 016F   0012    ' with the desired dot frequency. Allowed range is 10,000 to 1
                Hz.
 016F   0012    ' The FREQ parameter is a real number in Hz.
 016F   0012
 016F   0012    SUB SET.DOT.RATE(FREQ) STATIC
 0176   0012
 0176   0012    ' Limit freqency to in range
 0176   0012
 0176   0012            IF FREQ < 1 THEN FREQ = 1
 018F   0012            IF FREQ > 10000 THEN FREQ = 10000
 01A8   0012
 01A8   0012    ' Convert to count and check for 16 bit count or 32 bit count
 01A8   0012
 01A8   0012            COUNT = 2E6 / FREQ
 01B8   0012            IF COUNT < 65536! THEN GOTO DIVIDE16 ELSE GOTO DIVIDE32
 01CF   0012
 01CF   0012    ' Process count of 32 bits
 01CF   0012
 01CF   0012    DIVIDE32:
 01D0   0012            COUNTLI = INT((COUNT/32768!) + 1): 'Stage lower count
 01F0   0012            COUNTHI = INT(COUNT/COUNTLI): 'Form upper count
 020B   0012            GOTO SET.COUNT
 020F   0012
 020F   0012    ' Process count of 16 bits
 020F   0012
 020F   0012    DIVIDE16:
 0214   0012            COUNTLI = 2
 021B   0012            COUNTHI = INT(COUNT/2)
 0232   0012            GOTO SET.COUNT
 0236   0012
 0236   0012    ' Send the derived counts out to the counters
 0236   0012
 0236   0012    SET.COUNT:
 0237   0012            LSBI = COUNTLI MOD 256: ' Send out low 16 bits
 0248   0012            MSBI = INT(COUNTLI / 256)
 0263   0012            POKE &H0208,LSBI
 0273   0012            POKE &H0208,MSBI
 0283   0012
 0283   0012            LSBI = COUNTHI MOD 256: 'Send out high 16 bits
 0291   0012            MSBI = INT(COUNTHI / 256)
 02AC   0012            POKE &H0209,LSBI
 02BC   0012            POKE &H0209,MSBI
 02CC   0012
 02CC   0012            END SUB
 02D3   0012
 02D3   0012    REM $PAGEIF:27
```

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Reagent Jet Printer                                                    PAGE  6
Burr-Brown PCI-20000 custom driver                                     06-30-86
                                                                       08:38:16
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

02D3    0012    'SUBROUTINE     - SET.DOT.WIDTH
02D3    0012    '
02D3    0012    'DESCRIPTION:
02D3    0012    '       The SET.DOT.WIDTH subroutine loads the dot width one sh
                ot
02D3    0012    ' with the desired dot pulse width. Allowed range is .5 to 16,0
                00 usec.
02D3    0012    ' The dwidth parameter is a real number in usec.
02D3    0012
02D3    0012    SUB SET.DOT.WIDTH(DWIDTH) STATIC
02DA    0012
02DA    0012    ' Limit width to in range
02DA    0012
02DA    0012            IF DWIDTH < .5 THEN DWIDTH = .5
02F3    0012            IF DWIDTH > 16000 THEN DWIDTH = 16000
030C    0012
030C    0012    ' Convert to count
030C    0012
030C    0012            COUNT = DWIDTH / .5
031A    0012
031A    0012    ' Send the derived count out to the counter
031A    0012
031A    0012            LSB% = INT(COUNT MOD 256): ' Send out 16 bits
0331    0012            MSB% = INT(COUNT / 256)
0348    0012            POKE &H020A,LSB%
0358    0012            POKE &H020A,MSB%
0368    0012
0368    0012            END SUB
036F    0012
036F    0012    REM $PAGEIF:27
```

```
Reagent Jet Printer                                                    PAGE  7
Burr-Brown PCI-20000 custom driver                                     06-30-86
                                                                       08:38:16
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

036F    0012    'SUBROUTINE     - SET.STROBE.DELAY
036F    0012    '
036F    0012    'DESCRIPTION:
036F    0012    '       The SET.STROBE.DELAY subroutine loads the strobe delay
                one shot
036F    0012    ' with the desired strobe delay time. Allowed range is .5 to 16
                ,000 usec.
036F    0012    ' The delay parameter is a real number in usec.
036F    0012
036F    0012    SUB SET.STROBE.DELAY(DELAY) STATIC
0376    0012
0376    0012    ' Limit delay to in range
0376    0012
0376    0012            IF DELAY < .5 THEN DELAY = .5
038F    0012            IF DELAY > 16000 THEN DELAY = 16000
03AB    0012
03A8    0012    ' Convert to count
03A8    0012
03A8    0012            COUNT = DELAY / .5
03B6    0012
03B6    0012    ' Send the derived count out to the counter
03B6    0012
03B6    0012            LSB% = INT(COUNT MOD 256): ' Send out 16 bits
03CD    0012            MSB% = INT(COUNT / 256)
03E4    0012            POKE &H0206,LSB%
03F4    0012            POKE &H0206,MSB%
0404    0012
0404    0012            END SUB
040B    0012
040B    0012    REM $PAGEIF:16
040B    0012    'SUBROUTINE     - DIGITAL.OUT
040B    0012    '
040B    0012    'DESCRIPTION:
040B    0012    '       The DIGITAL.OUT subroutine sends the passed integer to
                the output
040B    0012    '        port 0.
040B    0012
040B    0012    SUB DIGITAL.OUT(BYTE%) STATIC
0412    0012
0412    0012    ' Send the byte to the port
0412    0012
0412    0012            POKE &H0080,BYTE%
0423    0012
0423    0012            END SUB
042A    0012
057F    0012

50426 Bytes Available
48723 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

```
Reagent Jet Printer                                                                    PAGE
Pattern Printing                                                                       09-1
                                                                                       06:4
Offset  Data    Source Line                                    IBM Personal Computer BASIC Compiler V
0030    0006    REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Pattern Printing' $LINESIZE:132
0030    0006    'MODULE   - "PATPRINT"
0030    0006    '
0030    0006    'AUTHOR   - N. A. Enevold
0030    0006    '
0030    0006    'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030    0006    '
0030    0006    'REVISION - 2.0 07-02-86 NAE Modified for MicroFab Printhead
0030    0006    '         - 1.1 03-07-86 NAE Added notes and final touches
0030    0006    '           1.0 02-03-86 NAE Creation of initial code
0030    0006    '
0030    0006    'SYSTEM   - This code can only be compiled by the BASCOM
0030    0006    '           COMPILER, it will not run under the INTERPRETER!!
0030    0006    '
0030    0006    'DESCRIPTION:
0030    0006    '       The printing module displays a menu in 3 columns of 4 rows each.  The first
0030    0006    '       column has data from the default reagent profile.  The second column has
0030    0006    '       data from the default pattern file.  The third column has standard printing
0030    0006    '       data.  The four arrow keys allow different menu items to be highlighted and
0030    0006    '       the values can be changed with the + or - keys or by entering the new number
0030    0006    '       followed by Enter.  P will cause the pattern to be printed, S will select the
0030    0006    '       notepad, and E will exit to the main program.  On the notepad, any single line
0030    0006    '       entered here will be sent to the printer.  A null line exits the notepad.
0030    0006    '
0030    0006    'DATA DICTIONARY
0030    0006    '       MENU%           Which menu item is highlighted (0-17)
0030    0006    '       DIFF%           Where to move menu highlight in response to arrow key
0030    0006    '       TYPE%           What key has been pressed during main scan
0030    0006    '       ELMNT           Number of elements in current pattern
0030    0006    '       SCRPAT%(50,5)   Array for storing elements in current pattern
0030    0006    '       REPEAT%         Counter for repeat printing the pattern
0030    0006    '       CT%             Counter for stepping through the pattern array during printing
0030    0006    '       RADIUS%         Radius of circle during printing
0030    0006    '       I% Y%           Offsets for start row/column position
0030    0006    '       REPI% REPY%     Repeat distances for repeat printing of patterns
0030    0006    '       SI% SY%         Starting I and Y positions for solid rectangles
0030    0006    '       EI% EY%         Ending I and Y positions for solid rectangles
0030    0006    '       I% J%           Counters used for reading pattern files into the array
0030    0006    '       TEMP%           Register for misc. integers
0030    0006    '       NOTELINE%       Pointer to which line is active in the notepad
0030    0006    '       MENU$(17,1)     Array of strings used to display menu items
0030    0006    '       A$              Single keystroke input destination
0030    0006    '       NOTE$           String entered in notepad and sent to printer
0030    0006    '       KEYBUF$         String entered from main scan and assigned to number of string field
0030    0006    '       REANAME$        Name of default reagent
0030    0006    '       PATNAME$        Name of default pattern
0030    0006    '       FILE$           Name of reagent data file and then pattern data file
0030    0006    '       MENU(11,4)      Array of values used in displaying menu item numbers
0030    0006    '       TEMP            Register for the temporary storage of real numbers
0030    0006    REM $PAGE
```

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Reagent Jet Printer                                                                    PAGE
Pattern Printing                                                                       09-1
                                                                                       08:4
Offset  Data    Source Line                                          IBM Personal Computer BASIC Compiler V:

0030    0006    SUB PATPRINT STATIC
0047    0006
0047    0006            DIM SCNDAT%(50,5),MENU$(17,1),MENU(17,4)
0048    0462
0048    0462            GOSUB INITIALIZE:       'read init. values and set screen
004E    0462
004E    0462            WHILE TYPE% <> 1
0059    0464
0059    0464              TYPE% = 0
0060    0464              A$ = ""
006A    0468
006A    0468              WHILE A$ = ""
0079    0468                A$ = INKEY$
0083    0468              WEND
0086    0468
0086    0468              IF A$ = "E" OR A$ = "e" THEN TYPE% = 1:       'exit sub
00B2    0468              IF A$ = "P" OR A$ = "p" THEN TYPE% = 2:       'print pattern
00DE    0468              IF A$ = "+" THEN TYPE% = 3:                   'increment variable
00F4    0468              IF A$ = "-" THEN TYPE% = 4:                   'decrement variable
010A    0468              IF A$ = CHR$(0) + CHR$(72) THEN TYPE% = 5:    'up arrow key
012F    0468              IF A$ = CHR$(0) + CHR$(80) THEN TYPE% = 6:    'down arrow key
0154    0468              IF A$ = CHR$(0) + CHR$(75) THEN TYPE% = 7:    'left arrow key
0179    0468              IF A$ = CHR$(0) + CHR$(77) THEN TYPE% = 8:    'right arrow key
019E    0468              IF A$ > CHR$(47) AND A$ < CHR$(58) THEN TYPE% = 9:' number 0-9
01D6    0468              IF A$ = "S" OR A$ = "s" THEN TYPE% = 10:      'enter scratchpad
0202    0468
0202    0468              ON TYPE% GOSUB T1, T2, T3, T4, T5, T6, T7, T8, T9, T10
021F    0468
021F    0468            WEND
0223    0468            TYPE% = 0
022A    0468
022A    0468            EXIT SUB
022E    0468
022E    0468    '************ SUBROUTINES FOR THIS MODULE ************
022E    0468    T10:    'scratch pad
0233    0468            SCREEN 0,0,2,2:COLOR 7,0
0256    0468            LOCATE NOTELINE%,1
0264    046A    NOTELOOP:
0269    046A            LINE INPUT NOTE$
0277    046E            IF NOTE$ = "" THEN SCREEN 0,0,0,0:RETURN
029F    046E            LPRINT NOTE$
02AC    046E            IF NOTELINE% < 24 THEN NOTELINE% = NOTELINE% + 1
02C0    046E            GOTO NOTELOOP
02C3    046E
02C3    046E
02C3    046E    T1:
02CB    046E            RETURN:                 'exit to print menu, no action
02CC    046E
02CC    046E    T3:             'process "+" key
02D1    046E            IF MENU(MENU%,0) >= MENU(MENU%,1) THEN MENU(MENU%,0) = MENU(MENU%,1):RETURN:    'check max value
033C    0470            MENU(MENU%,0) = MENU(MENU%,0) + MENU(MENU%,3):  'add increment
0372    0470            COLOR 0,7:GOSUB DISPMENU:RETURN:                    'show new value
0388    0470
0388    0470    T4:             'process "-" key
```

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Reagent Jet Printer                                                                    PAGE
Pattern Printing                                                                       09-17
                                                                                       08:49
Offset  Data    Source Line                                    IBM Personal Computer BASIC Compiler V2

03B2    0470            IF MENU(MENUX,0) <= MENU(MENUX,2) THEN MENU(MENUX,0) = MENU(MENUX,2):RETURN:    'check min value
03F8    0470            MENU(MENUX,0) = MENU(MENUX,0) - MENU(MENUX,3):  'sub increment
042E    0470            COLOR 0,7:GOSUB DISPMENU:RETURN:                        'show new value
0444    0470
0444    0470    T5:             'process up arrow key
0449    0470            IF MENUX MOD 6 = 0 THEN RETURN:                 'in top row already
045E    0470            DIFFX = -1:GOSUB NEWMENU:RETURN:        'move pointer up one
046F    0472
046F    0472    T6:             'process down arrow key
0474    0472            IF MENUX MOD 6 = 5 THEN RETURN:                 'in bottom row already
048A    0472            DIFFX = 1:GOSUB NEWMENU:RETURN:                 'move pointer down one
049B    0472                    .
049B    0472    T7:             'process left arrow key
04A0    0472            IF INT(MENUX / 6) = 0 THEN RETURN       'in left column already
04C0    0472            DIFFX = -6:GOSUB NEWMENU:RETURN:        'move pointer one left
04D1    0472
04D1    0472    T8:             'process right arrow key
04D6    0472            IF INT(MENUX / 6) = 2 THEN RETURN       'in right column already
04F9    0472            DIFFX = 6:GOSUB NEWMENU:RETURN:                 'move pointer one right
050A    0472
050A    0472    T9:             'input keys into KEYBUF$ until <cr> is entered
050F    0472            LOCATE 25,30:COLOR 31,0:PRINT "ENTER NEW VALUE";:COLOR 15,0
0541    0472            KEYBUF$ = A$
054B    0476            WHILE A$ <> CHR$(13)
055E    0476                    LOCATE 25,47:PRINT SPACE$(20);
057B    0476                    LOCATE 25,47:PRINT KEYBUF$;
0595    0476                    A$ = ""
059F    0476                    WHILE A$ = ""
05AE    0476                            A$ = INKEY$
05BB    0476                    WEND
05BB    0476                    IF A$ = CHR$(8) AND LEN(KEYBUF$) > 0 THEN KEYBUF$ = LEFT$(KEYBUF$,LEN(KEYBUF$)-1)
05FD    0476                    IF A$ > CHR$(31) THEN KEYBUF$ = KEYBUF$ + A$
061E    0476            WEND
0622    0476            TEMP = VAL(KEYBUF$)     'temp has value of keys input
0632    047A
0632    047A            'round off temp according to step size in menu array
0632    047A            TEMP = INT(TEMP / (MENU(MENUX,3)) + .5) * MENU(MENUX,3)
066B    047A
066B    047A            'test TEMP for maximum and minimum values in menu array
066B    047A            IF TEMP > MENU(MENUX,1) THEN TEMP = MENU(MENUX,1)
06AA    047A            IF TEMP < MENU(MENUX,2) THEN TEMP = MENU(MENUX,2)
06E9    047A
06E9    047A            'insert new value into menu array and update screen
06E9    047A            MENU(MENUX,0) = TEMP
0705    047A            LOCATE 25,30:PRINT SPACE$(40);
0722    047A            COLOR 0,7:GOSUB DISPMENU
0734    047A            RETURN
0738    047A
0738    047A    T2:     'set Burr-Brown board then print desired pattern
073D    047A
073D    047A            BEEP:COLOR 15,0:LOCATE 25,1
075A    047A            PRINT "Set Potentiometers on Printer....then Press any Key";
0767    047A            A$ = ""
0771    047A            WHILE A$ = ""
```

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5  Reagent Jet Printer                                                                    PAGE
   Pattern Printing                                                                       09-17
                                                                                          08:49
   Offset  Data    Source Line                                          IBM Personal Computer BASIC Compiler V2

   0780    047A                A$ = INKEY$
10 078A    047A            WEND
   078D    047A            LOCATE 25,1:PRINT SPACE$(79);
   07AA    047A
   07AA    047A            'enter drop parameters into burr-brown board
   07AA    047A            TEMP = MENU(0,0):CALL SET.DOT.RATE(TEMP)
   07B3    047A            TEMP = 5:CALL SET.DOT.WIDTH(TEMP)
15 07ED    047A            TEMP = MENU(2,0):CALL SET.STROBE.DELAY(TEMP)
   0819    047A            CALL DOT.ON
   0825    047A
   0825    047A            TEMPI = 4
   082C    047C            CALL DIGITAL.OUT(TEMPI)
   083C    047C            TEMPI = 0:                      'pulse RESET line
20 0843    047C            CALL DIGITAL.OUT(TEMPI)
   0853    047C            TEMPI = 4
   085A    047C            CALL DIGITAL.OUT(TEMPI)
   086A    047C
   086A    047C            JI = CINT(MENU(1,0) * 255 / 150): 'set pulse amplitude by pulsing HIGHER signal JI number of times
   0893    047E            FOR II = 1 TO JI
25 08A0    0480                TEMPI = 6:                  'set HIGHER true
   08A7    0480                CALL DIGITAL.OUT(TEMPI)
   08B7    0480                TEMPI = 4:                  'set HIGHER false
   08BE    0480                CALL DIGITAL.OUT(TEMPI)
   08CE    0480            NEXT II
30 08E0    0482
   08E0    0482            'establish COM1: and initialize plotter
   08E0    0482            OPEN "COM1:2400,N,8,1,CD 65535" AS #1
   08F2    0482            PRINT #1,";:UECS,EFV1,n";
   0902    0482
   0902    0482            'move nozzle offset and establish new origin
35 0902    0482            PRINT #1,"AO";
   0912    0482
   0912    0482            'calculate row/colum location, move there, and set new origin
   0912    0482            XI = (MENU(12,0)-1) * (MENU(14,0) / 0.005)
   0954    0484            YI = (MENU(13,0)-1) * (MENU(15,0) / 0.005)
   0996    0486            PRINT #1,XI;YI;"D";
40 09B4    0486
   09B4    0486            'print the pattern using repeat count
   09B4    0486            REPYI = MENU(8,0) / 0.005
   09D7    0488            REPXI = MENU(9,0) / 0.005
   09FA    048A
   09FA    048A            FOR REPEATI = 0 TO MENU(7,0)
45 0A1C    048C
   0A1C    048C                    'print the pattern
   0A1C    048C                    FOR CTI = 0 TO ELNUMI - 1
   0A2A    0490                            ON SCNDATI(CTI,0) GOSUB PLINE, PRECT, FSRECT, PCIRCL
   0A4C    0492                    NEXT CTI
   0A5E    0492
50 0A5E    0492                    PRINT #1,"A,0,0,";      'return to origin
   0A6E    0492                    PRINT #1,REPXI;REPYI;"D";: 'move to next pattern
   0A8C    0492            NEXT REPEATI
   0AA1    0494
   0AA1    0494            PRINT #1,"H";:  'return plotter to original HOME
   0AB1    0494
55
```

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Reagent Jet Printer                                                                    PAGE
Pattern Printing                                                                       09-17
                                                                                       08:49
Offset  Data    Source Line                                  IBM Personal Computer BASIC Compiler V2

0AB1    0494            CLOSE #1:       'disable com1:
0AB8    0494
0ABB    0494            RETURN
0ABC    0494
0ABC    0494    PLINE:
0AC1    0494            PRINT #1,SCNDATI%(CTI%,2);SCNDATI%(CTI%,1);"D";
0B03    0494            PRINT #1,SCNDATI%(CTI%,4);SCNDATI%(CTI%,3);"U";
0B45    0494            RETURN
0B49    0494
0B49    0494    PRECT:
0B4E    0494            PRINT #1,SCNDATI%(CTI%,2);SCNDATI%(CTI%,1);"D";
0B90    0494            PRINT #1,SCNDATI%(CTI%,4);SCNDATI%(CTI%,1);
0BCC    0494            PRINT #1,SCNDATI%(CTI%,4);SCNDATI%(CTI%,3);
0C08    0494            PRINT #1,SCNDATI%(CTI%,2);SCNDATI%(CTI%,3);
0C44    0494            PRINT #1,SCNDATI%(CTI%,2);SCNDATI%(CTI%,1);"U";
0C86    0494            RETURN
0C8A    0494
0C8A    0494    PCIRCL:
0C8F    0494            RADIUSI% = SQR((SCNDATI%(CTI%,3)-SCNDATI%(CTI%,1))^2 + (SCNDATI%(CTI%,4)-SCNDATI%(CTI%,2))^2)
0D1A    0496            PRINT #1,"CC ";SCNDATI%(CTI%,2);SCNDATI%(CTI%,1);RADIUSI%;
0D63    0496            RETURN
0D67    0496
0D67    0496    PSRECT:
0D6C    0496            SXI% = SCNDATI%(CTI%,4):EXI% = SCNDATI%(CTI%,2)
0DA0    049A            SYI% = SCNDATI%(CTI%,3):EYI% = SCNDATI%(CTI%,1)
0DD4    049E            IF EXI% <= SXI% THEN SXI% = SCNDATI%(CTI%,2):EXI% = SCNDATI%(CTI%,4)
0E15    049E            IF EYI% <= SYI% THEN SYI% = SCNDATI%(CTI%,1):EYI% = SCNDATI%(CTI%,3)
0E56    049E
0E56    049E            PRINT #1,SXI%;SYI;"D";
0E74    049E
0E74    049E            IF EXI% - SXI% >= EYI% - SYI% THEN GOSUB STEPY ELSE GOSUB STEPX
0E9D    049E
0E9D    049E            PRINT #1,"U";
0EAD    049E            RETURN
0EB1    049E
0EB1    049E    STEPY:
0EB6    049E            PRINT #1,EXI%;SYI;
0ECE    049E            SYI% = SYI% + 1
0ED7    049E            IF SYI% > EYI% THEN RETURN
0EE8    049E            PRINT #1,EXI%;SYI;SXI%;SYI;
0F0E    049E            SYI% = SYI% + 1
0F17    049E            IF SYI% > EYI% THEN RETURN
0F28    049E            PRINT #1,SXI%;SYI;
0F40    049E            GOTO STEPY
0F44    049E
0F44    049E    STEPX:
0F49    049E            PRINT #1,SXI%;EYI;
0F61    049E            SXI% = SXI% + 1
0F6A    049E            IF SXI% > EXI% THEN RETURN
0F7B    049E            PRINT #1,SXI%;EYI;SXI%;SYI;
0FA1    049E            SXI% = SXI% + 1
0FAA    049E            IF SXI% > EXI% THEN RETURN
0FBB    049E            PRINT #1,SXI%;SYI;
0FD3    049E            GOTO STEPX
```

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Reagent Jet Printer                                                                    PAGE
Pattern Printing                                                                       09-17
                                                                                       08:49
Offset  Data    Source Line                                    IBM Personal Computer BASIC Compiler V2

 0FD7   049E
 0FD7   049E    NEWMENU: 'write old item in yellow, point to and highlight new item
 0FDC   049E             COLOR 14,0:GOSUB DISPMENU
 0FEE   049E             MENUI = MENUI + DIFFI
 0FFA   049E             IF MENUI = 10 THEN MENUI = 9
 100C   049E             IF MENUI = 11 THEN MENUI = 9
 101E   049E             IF MENUI > 15 THEN MENUI = 15
 1030   049E             COLOR 0,7:GOSUB DISPMENU:RETURN
 1046   049E
 1046   049E    INITIALIZE:
 104B   049E             'change to screen 0 and display messages
 104B   049E             SCREEN 0,0,1,1:COLOR 7,0:CLS:LOCATE 10,17:PRINT "Loading selected Reagent and Pattern Data Files";
 108F   049E             LOCATE 12,33:PRINT "Please Wait..."
 10A9   049E
 10A9   049E             'initialize notepad on screen 2
 10A9   049E             SCREEN 0,0,2,1:CLS:COLOR 15
 10CE   049E             PRINT"Digital Notepad - - -All information typed here is sent to the printer"
 10DB   049E             NOTELINEI = 3
 10E2   049E
 10E2   049E             'initialize menu arrays
 10E2   049E             RESTORE ARRDATA
 10E9   049E             FOR II=0 TO 17
 10EF   049E                     READ MENUS(II,0),MENUS(II,1):
 111F   049E                     READ MENU(II,1),MENU(II,2),MENU(II,3),MENU(II,4)
 1180   049E             NEXT II
 1193   049E
 1193   049E             'get default reagent file and read values
 1193   049E
 1193   049E             OPEN "READEF.RJP" FOR INPUT AS #1
 11A4   049E             INPUT #1,FILE$
 11B6   04A2             INPUT #1,REANAME$
 11CB   04A6             CLOSE #1
 11CF   04A6
 11CF   04A6             OPEN FILE$ FOR INPUT AS #1:     'get reagent data
 11E0   04A6             INPUT #1,MENU(0,0):             'frequency
 1200   04A6             INPUT #1,MENU(1,0):             'amplitude
 1223   04A6             INPUT #1,MENU(2,0):             'strobe delay
 1246   04A6             INPUT #1,MENU(3,0):             'pulse width
 1269   04A6             INPUT #1,MENU(4,0):             'rise time
 128C   04A6             INPUT #1,MENU(5,0):             'fall time
 12B1   04A6             CLOSE #1
 12B8   04A6
 12B8   04A6             'get default pattern file and read values
 12B8   04A6
 12B8   04A6             OPEN "PATDEF.RJP" FOR INPUT AS #1
 12C9   04A6             INPUT #1,FILE$
 12DB   04A6             INPUT #1,PATNAME$
 12ED   04AA             CLOSE #1
 12F4   04AA
 12F4   04AA             OPEN FILE$ FOR INPUT AS #1:     'get pattern data
 1305   04AA             INPUT #1,ELNUMI
 1317   04AA             INPUT #1,MENU(6,0):             'grid
 132A   04AA             INPUT #1,MENU(7,0):             'repeat count
 133D   04AA             INPUT #1,MENU(8,0):             'x offset
```

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Reagent Jet Printer                                                                    PAGE
Pattern Printing                                                                       09-17
                                                                                       08:49
Offset  Data    Source Line                                          IBM Personal Computer BASIC Compiler V2

 13B0   04AA            INPUT #1,MENU(9,0):             'y offset
 13A3   04AA            FOR IX = 0 TO ELNUMI-1
 13B1   04AC                    FOR JX = 0 TO 5
 13B7   04AC                            INPUT #1,SCNDATI(IX,JX)
 13DB   04AC                    NEXT JX
 13EB   04AC            NEXT IX
 13FD   04AC            CLOSE #1
 1404   04AC
 14C4   04AC            'set remaining parameters in menu array
 1404   04AC
 1404   04AC            MENU(12,0) = 1:                 'row 1
 1420   04AC            MENU(13,0) = 1:                 'column 1
 143C   04AC            MENU(14,0) = 0:                 'row spacing
 145B   04AC            MENU(15,0) = 0:                 'column spacing
 1474   04AC
 1474   04AC            'change active displayed screen to screen 0 to draw and display parameters
 1474   04AC
 1474   04AC            SCREEN 0,0,0,1:CLS
 1491   04AC
 1491   04AC            COLOR 13:LOCATE 1,32:PRINT "REAGENT PRINTING";
 14B2   04AC            COLOR 9
 14B9   04AC            FOR I=2 TO 79
 14C3   04AC                    LOCATE 3,I:PRINT CHR$(196);:LOCATE 5,I:PRINT CHR$(205);:LOCATE 18,I:PRINT CHR$(196);
 1523   04B0            NEXT I
 153E   04B0            FOR I=4 TO 17
 1548   04B0                    LOCATE 1,1:PRINT CHR$(179);:LOCATE 1,28:PRINT CHR$(186);:LOCATE 1,54:PRINT CHR$(186);:LOCATE 1,E
                RINT CHR$(179);
 15C8   04B0            NEXT I
 15E6   04B0            RESTORE TABLE
 15ED   04B0            FOR I=1 TO 12
 15F7   04B0                    READ RX,CX,NX:LOCATE RX,CX:PRINT CHR$(NX);
 162A   04B6            NEXT I
 1645   04B6
 1645   04B6            'display 16 menu choices in yellow
 1645   04B6
 1645   04B6            COLOR 14,0
 1651   04B6            FOR MENUX = 0 TO 15
 1657   04B6                    GOSUB DISPMENU
 165D   04B6            NEXT MENUX
 166D   04B6
 166D   04B6            'set for first menu entry and highlight it
 166D   04B6            MENUX = 0:COLOR 0,7
 1680   04B6            GOSUB DISPMENU
 16B6   04B6
 16B6   04B6            'print three headings and instructions
 16B6   04B6            COLOR 10,0
 16B2   04B6            LOCATE 4,14.5-LEN(REANAME$)/2:PRINT REANAME$;
 16C1   04B6            LOCATE 4,41-LEN(PATNAME$)/2:PRINT PATNAME$;
 16F0   04B6            LOCATE 4,60:PRINT "PRINT LOCATION";
 170A   04B6
 170A   04B6            COLOR 7:LOCATE 19,20:PRINT "Use ";:COLOR 15:PRINT CHR$(27);CHR$(32);CHR$(26);
 1754   04B6            PRINT CHR$(32);CHR$(24);CHR$(32);CHR$(25);:COLOR 7:PRINT " to position highlighted cursor";
 1793   04B6            LOCATE 20,18:PRINT "Use ";:COLOR 15:PRINT "+";:COLOR 7:PRINT " or ";:COLOR 15:PRINT "-";
 17E9   04B6            COLOR 7:PRINT" to scroll current value up or down";
```

Reagent Jet Printer
Pattern Printing

PAGE
09-17-
08:49:
IBM Personal Computer BASIC Compiler V2.

```
Offset  Data    Source Line

17FD    04B6            LOCATE 21,5:PRINT "Use ";:COLOR 15:PRINT "P";:COLOR 7:PRINT " to print pattern or ";
183F    04B6            COLOR 15:PRINT "E";:COLOR 7:PRINT " to exit to print menu";
1867    04B6            PRINT " or ";:COLOR 15:PRINT "S";:COLOR 7:PRINT " to use notepad";
189C    04B6
189C    04B6            'set screen to view menu just created and exit
189C    04B6
189C    04B6            SCREEN 0,0,0,0
18B1    04B6            RETURN
18B5    04B6
18B5    04B6    DISPMENU:
18BA    04B6            IF MENUZ = 10 OR MENUZ = 11 THEN RETURN
18DE    04B6            LOCATE (MENUZ MOD 6)*2+7,(INT(MENUZ/6)*28+2)-2*INT(MENUZ/12)
193B    04B6            PRINT MENU$(MENUZ,0)
1956    04B6            LOCATE (MENUZ MOD 6)*2+7,MENU(MENUZ,4)
1988    04B6            PRINT USING MENU$(MENUZ,1);MENU(MENUZ,0);
19BB    04B6            RETURN
19BF    04B6    REM $PAGE
```

```
Reagent Jet Printer                                                                    PAGE
Pattern Printing                                                                       09-17
                                                                                       08:49
Offset  Data   Source Line                                        IBM Personal Computer BASIC Compiler V2

 19BF   04B6   '************ DATA USED BY THIS MODULE ************
 19BF   04B6
 19BF   04B6   ARRDATA:
 19C4   04B6           DATA "Dot Frequency          Hz","##,###",10000,1,1,16
 19C6   04B6           DATA "Amplitude              V ","###",150.0,1,19
 19C8   04B6           DATA "Strobe Delay           uS","##,###.#",15999.5,.5..5,16
 19CA   04B6           DATA "Pulse Width              ","###",999,0,1,19
 19CC   04B6           DATA "Rise Time                ","###",999,0,1,19
 19CE   04B6           DATA "Fall Time                ","###",999,0,1,19
 19D0   04B6           DATA "Grid Size            in","#.###",.005,.005,.005,45
 19D2   04B6           DATA "Repeat Count             ","##",99,0,1,47
 19D4   04B6           DATA "X Axis Offset        in","#.###",2,0,.005,45
 19D6   04B6           DATA "Y Axis Offset        in","#.###",2,0,.005,45
 19D8   04B6           DATA "","",0,0,0,0
 19DA   04B6           DATA "","",0,0,0,0
 19DC   04B6           DATA "Row to Print       ","##",99,1,1,74
 19DE   04B6           DATA "Column to Print    ","##",99,1,1,74
 19E0   04B6           DATA "Row Spacing          in","#.###",3,0,.005,72
 19E2   04B6           DATA "Column Spacing       in","#.###",3,0,.005,72
 19E4   04B6           DATA "","",0,0,0,0
 19E6   04B6           DATA "","",0,0,0,0
 19E8   04B6
 19E8   04B6   TABLE:
 19ED   04B6           DATA 3,1,218
 19EF   04B6           DATA 3,28,210
 19F1   04B6           DATA 3,54,210
 19F3   04B6           DATA 3,80,191
 19F5   04B6           DATA 5,1,198
 19F7   04B6           DATA 5,28,206
 19F9   04B6           DATA 5,54,206
 19FB   04B6           DATA 5,80,181
 19FD   04B6           DATA 18,1,192
 19FF   04B6           DATA 18,28,208
 1A01   04B6           DATA 18,54,208
 1A03   04B6           DATA 18,80,217
 1A05   04B6
 1A05   04B6   END SUB
 1A0C   04B6
 1A0C   04B6
 2069   04B6

50426 Bytes Available
44716 Bytes Free

     0 Warning Error(s)
     0 Severe  Error(s)
```

```
Reagent Jet Printer                                                    PAGE  1
Reagent Filing                                                         07-09-86
                                                                       15:04:35
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

0030  0006  REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Reagent Filing'
0030  0006  'MODULE   - "REAFILE" File Handling for reagents
0030  0006  '
0030  0006  'AUTHOR   - N. A. Enevold
0030  0006  '
0030  0006  'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030  0006  '
0030  0006  'REVISION - 1.1 03-07-86 NAE Added notes and description
0030  0006  '           1.0 02-14-86 NAE Creation of initial code
0030  0006  '
0030  0006  'SYSTEM   - This code can only be compiled by the BASCOM
0030  0006  '           COMPILER, it will not run under the INTERPRETER!!
0030  0006  '
0030  0006  'DESCRIPTION:
0030  0006  '       This module allow file handling for reagents.  When inv
                oked, it displays
0030  0006  '       the current contents of the reagent directory in 4 colu
                mns of 20 entries
0030  0006  '       each.  The reagent which is currently selected for prin
                ting is marked by
0030  0006  '       an asterisk to the left of the reagent name.  After the
                 directory is listed
0030  0006  '       the user is presented with 5 menu choices.  The left an
                d right arrows are
0030  0006  '       used to highlight menu items and the enter key is used
                to invoke action.
0030  0006  '       The menu choices and their actions are:
0030  0006  '
0030  0006  '               DELETE - Remove a reagent file from the directo
                ry
0030  0006  '               COPY -   Copy a reagent file to a new reagent n
                ame, saving the old reagent
0030  0006  '               RENAME - Change the name of the reagent without
                 changing the reagent itself
0030  0006  '               SELECT - Selct a reagent for printing
0030  0006  '               EXIT -   Return to the main menu
0030  0006  '
0030  0006  'DATA DICTIONARY
0030  0006  '       TYPE%       Which type of valid key was pushed
0030  0006  '       MENU%       Which menu item is being pointer to (0-4)
0030  0006  '       DIFF%       Distance to move MENU% at left or right arro
                w
0030  0006  '       FLAG%       Error type 0-4
0030  0006  '       POINTER%    Position of REANAME$ in directory list
0030  0006  '       REANUM%             Number of reagent names in directory
                 list
0030  0006  '       TEMP%       Storage for integers during reagent copy
0030  0006  '       A$          Misc. input string
0030  0006  '       FUNCT$      Printed at bottom of screen during prompt fo
                r reagent name
0030  0006  '       REANAME$    Reagent name currently being worked on
0030  0006  '       SELNAME$    Reagent name currently selected for printing
0030  0006  '       FILE$       Filename of reagent data file
0030  0006  '       SFILE$      Filename for source reagent data file used d
```

```
Reagent Jet Printer                                                    PAGE   2
Reagent Filing                                                         07-09-86
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Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

                during copy
 0030   0006    '       DFILE$      Filename for destination reagent data file u
                sed during copy
 0030   0006    '       NEWNAME$    New reagent name for COPY and RENAME
 0030   0006    '       TEMP$       Reagent names are held here as the directory
                 is being re-written
 0030   0006    '       NEWFILE$    Destination filename used while copying reag
                ent data files
 0030   0006    '       MESSAGE$    A message printed at the bottom of the scree
                n
 0030   0006    '       MENU$(4,1) Array of strings containing the short and lo
                ng menu names
 0030   0006    '       ERRMSG$     Message printed when any error occurs
 0030   0006    '       ERR$        Appended to ERRMSG$ to indicate nature of er
                ror
 0030   0006    REM $PAGE


Reagent Jet Printer                                                    PAGE   3
Reagent Filing                                                         07-09-86
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Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    SUB REAGENT.FILE STATIC
 0047   0006
 0047   0006            GOSUB INITIALIZE
 004D   0006            TYPE% = 0
 0054   0008
 0054   0008            WHILE TYPE% <> 3
 005F   0008                    A$ = ""
 0069   000C                    WHILE A$ = ""
 0078   000C                            A$ = INKEY$
 0082   000C                    WEND
 0085   000C                    IF A$ = CHR$(0) + CHR$(75) THEN TYPE% = 1:
                'left arrow
 00AA   000C                    IF A$ = CHR$(0) + CHR$(77) THEN TYPE% = 2:
                'right arrow
 00CF   000C                    IF A$ = CHR$(13) THEN TYPE% = 3:
                '<cr> to execute selection
 00E9   000C
 00E9   000C                    ON TYPE% GOSUB T1, T2, T3
 00F8   000C            WEND
 00FC   000C
 00FC   000C            EXIT SUB
 0100   000C
 0100   000C    REM $PAGE
```

Reagent Jet Printer
Reagent Filing

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Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
0100  000C  '******** SUB-ROUTINES FOR THIS MODULE ********
0100  000C
0100  000C  T1:             'left arrow
0105  000C          TYPE% = 0
010C  000C          IF MENU% = 0 THEN RETURN
0118  000E          DIFF% = -1
0122  0010          GOSUB NEW.MENU
0128  0010          RETURN
012C  0010
012C  0010  T2:             'right arrow
0131  0010          TYPE% = 0
0138  0010          IF MENU% = 4 THEN RETURN
0147  0010          DIFF% = 1
014E  0010          GOSUB NEW.MENU
0154  0010          RETURN
0158  0010
0158  0010  T3:             '<cr>  (execute selected menu item)
015D  0010          LOCATE 25,1:PRINT SPACE$(79);
017A  0010          ON MENU% + 1 GOSUB T3A, T3B, T3C, T3D, T3E
018F  0010          GOSUB MENU.ON
0195  0010          RETURN
0199  0010
0199  0010  REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  5
Reagent Filing                                                         07-09-86
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Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0199   0010    T3A:            'delete reagent
 019E   0010            TYPE% = 0
 01A5   0010            FUNCT$ = "Delete"
 01AF   0014            GOSUB GET.SOURCE
 01B5   0014            IF LEN(REANAME$) = 0 THEN RETURN
 01C7   0018            IF REANAME$ = SELNAME$ THEN FLAG% = 4:GOSUB SHOW.ERROR:
                    RETURN
 01E7   001E            GOSUB SEARCH
 01ED   001E            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
 0209   0020
 0209   0020            MESSAGE$ = "Deleting " + REANAME$ + "     Please Wait..
                    ."
 0220   0024            GOSUB MESSAGE.ON
 0226   0024
 0226   0024                    'rewrite directory deleting REANAME$ as indicat
                    ed by POINTER%
 0226   0024            KILL "READIR.OLD"
 022D   0024            NAME "READIR.RJP" AS "READIR.OLD"
 0237   0024            OPEN "READIR.OLD" FOR INPUT AS #1
 0248   0024            OPEN "READIR.RJP" FOR OUTPUT AS #2
 025A   0024
 025A   0024            INPUT #1, REANUM%
 026C   0026            REANUM% = REANUM% - 1
 0275   0026            WRITE #2,REANUM%
 0286   0026
 0286   0026            IF REANUM% = 0 THEN GOTO DIR.DONE
 0295   0026            FOR I% = 1 TO REANUM% + 1
 02A4   0028                    INPUT #1,REANAME$
 02B6   0028                    IF I% <> POINTER% THEN PRINT #2,REANAME$
 02D3   002A            NEXT I%
 02E5   002A
 02E5   002A    DIR.DONE:
 02EA   002A            CLOSE #1:CLOSE #2
 02F8   002A
 02F8   002A                    'remove data file
 02F8   002A            FILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER%))-1) +
                    "REA.RJP"
 031C   002E            KILL FILE$
 0323   002E
 0323   002E                    'rename remaining data files to maintain linked
                     list to directory
 0323   002E            WHILE (REANUM% + 1) > POINTER%
 0333   002E                    SFILE$ = RIGHT$(STR$(POINTER%+1),LEN(STR$(POINT
                    ER%+1))-1) + "REA.RJP"
 0359   0032                    DFILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER
                    %))-1) + "REA.RJP"
 037D   0036                    NAME SFILE$ AS DFILE$
 0387   0036                    POINTER% = POINTER% + 1
 0390   0036            WEND
 0393   0036
 0393   0036            GOSUB MESSAGE.OFF
 0399   0036            REANAME$ = SELNAME$
 03A3   0036            GOSUB T3DA
 03A9   0036            GOSUB DISP.DIR
```

```
03AF  0036          RETURN
03B3  0036
03B3  0036    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

03B3    0036    T38:    'copy reagent
03B8    0036            TYPE% = 0
03BF    0036            IF REANUM% = 80 THEN FLAG% = 3:GOSUB SHOW.ERROR:RETURN
03DB    0036            FUNCT$ = "Copy"
03E5    0036            GOSUB GET.SOURCE
03EB    0036            IF LEN(REANAME$) = 0 THEN RETURN
03FD    0036            GOSUB SEARCH
0403    0036            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
041F    0036
041F    0036            GOSUB GET.NEW.NAME
0425    0036            IF LEN(NEWNAME$) = 0 THEN RETURN
0437    003A            IF LEN(NEWNAME$) > 15 THEN FLAG% = 2:GOSUB SHOW.ERROR:R
                    ETURN
0457    003A
0457    003A            MESSAGE$ = "Copying " + REANAME$ + " to " + NEWNAME$ +
                    "    Please wait.."
047C    003A            GOSUB MESSAGE.ON
0482    003A
0482    003A                    'add new name at end of directory
0482    003A            KILL "READIR.OLD"
0489    003A            NAME "READIR.RJP" AS "READIR.OLD"
0493    003A            OPEN "READIR.OLD" FOR INPUT AS #1
04A4    003A            OPEN "READIR.RJP" FOR OUTPUT AS #2
04B6    003A
04B6    003A            INPUT #1, REANUM%
04C8    003A            REANUM% = REANUM% + 1
04D1    003A            WRITE #2,REANUM%
04E2    003A
04E2    003A            FOR I% = 1 TO REANUM% - 1
04F1    003C                    INPUT #1,TEMP$
0503    0040                    PRINT #2,TEMP$
0513    0040            NEXT I%
0525    0040            PRINT #2,NEWNAME$
0535    0040
0535    0040            CLOSE #1:CLOSE #2
0543    0040
0543    0040                    'create copy of data file
0543    0040            FILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER%))-1) +
                    "REA.RJP"
0567    0040            NEWFILE$ = RIGHT$(STR$(REANUM%),LEN(STR$(REANUM%))-1) +
                     "REA.RJP"
058B    0044
058B    0044            OPEN FILE$ FOR INPUT AS #1
059C    0044            OPEN NEWFILE$ FOR OUTPUT AS #2
05AE    0044
05AE    0044            INPUT #1,TEMP
05C0    0048            WRITE #2,TEMP:  'frequency
05D0    0048            INPUT #1,TEMP
05E2    0048            WRITE #2,TEMP:  'pulse width
05F2    0048            INPUT #1,TEMP
0604    0048            WRITE #2,TEMP:  'strobe delay
0614    0048            INPUT #1,TEMP
0626    0048            WRITE #2,TEMP:  'nozzle
0636    0048
```

```
Reagent Jet Printer                                                    PAGE  8
Reagent Filing                                                         07-09-86
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Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0636   0048            INPUT #1,TEMP$
 0648   0048            PRINT #2,TEMP$:          'concentration
 065B   0048            INPUT #1,TEMP$
 066A   0048            PRINT #2,TEMP$:          'density
 067A   0048            INPUT #1,TEMP$
 068C   0048            PRINT #2,TEMP$:          'viscosity
 069C   0048
 069C   0048            CLOSE #1:CLOSE #2
 06AA   0048
 06AA   0048            GOSUB MESSAGE.OFF
 06B0   0048            GOSUB DISP.DIR
 06B6   0048            RETURN
 06BA   0048
 06BA   0048    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 06BA   0048    TJC:    'rename reagent
 06BF   0048            TYPE% = 0
 06C6   0048            FUNCT$ = "Rename"
 06D0   0048            GOSUB GET.SOURCE
 06D6   0048            IF LEN(REANAME$) = 0 THEN RETURN
 06E8   0048            GOSUB SEARCH
 06EE   0048            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
 070A   0048
 070A   0048            GOSUB GET.NEW.NAME
 0710   0048            IF LEN(NEWNAME$) = 0 THEN RETURN
 0722   0048            IF LEN(NEWNAME$) > 15 THEN FLAG% = 2:GOSUB SHOW.ERROR:R
                    ETURN
 0742   0048            IF NEWNAME$ = REANAME$ THEN RETURN
 0755   0048            MESSAGE$ = "Renaming " + REANAME$ + " to " + NEWNAME$ +
                     "    Please wait.."
 077A   0048            GOSUB MESSAGE.ON
 07B0   0048
 07B0   0048                    'renaming reagent name in directory
 07B0   0048            KILL "READIR.OLD"
 07B7   0048            NAME "READIR.RJP" AS "READIR.OLD"
 07C1   0048            OPEN "READIR.OLD" FOR INPUT AS #1
 07A2   0048            OPEN "READIR.RJP" FOR OUTPUT AS #2
 07B4   0048
 07B4   0048            INPUT #1, REANUM%
 07C6   0048            WRITE #2,REANUM%
 07D7   0048
 07D7   0048            FOR I% = 1 TO REANUM%
 07E4   004A                    INPUT #1,TEMP$
 07F6   004A                    IF I% <> POINTER% THEN PRINT #2,TEMP$
 0813   004A                    IF I% = POINTER% THEN PRINT #2,NEWNAME$
 0830   004A            NEXT I%
 0842   004A
 0842   004A            CLOSE #1:CLOSE #2
 0850   004A
 0850   004A            GOSUB MESSAGE.OFF
 0856   004A            IF REANAME$ = SELNAME$ THEN REANAME$ = NEWNAME$:GOSUB T
                    JDA
 0875   004A            GOSUB DISP.DIR
 087B   004A            RETURN
 087F   004A
 087F   004A    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 067F   004A    TJD:    'select reagent for printing
 0682   004A            TYPE% = 0
 0688   004A            FUNCT$ = "Select"
 0895   004A            GOSUB GET.SOURCE
 0898   004A            IF LEN(REANAME$) = 0 THEN RETURN
 08AD   004A            IF REANAME$ = SELNAME$ THEN RETURN
 08C0   004A            GOSUB TJDA
 08C6   004A            GOSUB DISP.DIR
 08CC   004A            RETURN
 08D0   004A
 08D0   004A    TJDA:
 08D5   004A            GOSUB SEARCH
 08DB   004A            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
 08F7   004A
 08F7   004A            MESSAGE$ = "Selecting " + REANAME$ + "     Please Wait.
                ..."
 090E   004A            GOSUB MESSAGE.ON
 0914   004A
 0914   004A                    'change entrys in reagent default file READEF.R
                JP
 0914   004A            OPEN "READEF.RJP" FOR OUTPUT AS #1
 0926   004A            FILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER%))-1) +
                "REA.RJP"
 094A   004A
 094A   004A            PRINT #1,FILE$
 095A   004A            PRINT #1,REANAME$
 096A   004A
 096A   004A            CLOSE #1
 0971   004A            GOSUB MESSAGE.OFF
 0977   004A            RETURN
 097B   004A
 097B   004A    TJE:    'exit reagent filing
 0980   004A            RETURN
 0984   004A
 0984   004A    REM $PAGE
```


BAD ORIGINAL

```
Reagent Jet Printer                                                    PAGE  11
Reagent Filing                                                         07-09-86
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Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0984   004A    SEARCH:
 0989   004A            POINTER% = 0
 0990   004A            OPEN "READIR.RJP" FOR INPUT AS #1
 09A1   004A            INPUT #1,REANUM%:'      get number of reagents in direc
                tory
 09B3   004A            IF REANUM% = 0 THEN CLOSE #1:RETURN
 09C9   004A            TEMP$ = ""
 09D3   004A            WHILE (POINTER% < REANUM%) AND (REANAME$ <> TEMP$)
 09FB   004A                    LINE INPUT #1,TEMP$
 0A08   004A                    POINTER% = POINTER% + 1
 0A11   004A            WEND
 0A14   004A            IF REANAME$ <> TEMP$ THEN POINTER% = 0
 0A2A   004A            CLOSE #1
 0A31   004A            RETURN
 0A35   004A
 0A35   004A    GET.SOURCE:
 0A3A   004A            LOCATE 25,1:COLOR 15,0:PRINT "Enter Reagent Name to "FU
                NCT$"  ";
 0A6C   004A            LINE INPUT;"",REANAME$
 0A7A   004A            LOCATE 25,1:PRINT SPACE$(79);
 0A97   004A            RETURN
 0A9B   004A
 0A9B   004A    GET.NEW.NAME:
 0AA0   004A            LOCATE 25,1:COLOR 15,0:PRINT "Enter New Reagent Name ";
 0AC6   004A            LINE INPUT;"",NEWNAME$
 0AD4   004A            LOCATE 25,1:PRINT SPACE$(79);
 0AF1   004A            RETURN
 0AF5   004A
 0AF5   004A    DISP.DIR:       'display reagent directory in 4 columns of 20 r
                ows
 0AFA   004A                    'read selected reagent into SELNAME$
 0AFA   004A            OPEN "READEF.RJP" FOR INPUT AS #1
 0B08   004A            INPUT #1,SELNAME$:      'read and discard data file nam
                e
 0B1D   004A            INPUT #1,SELNAME$:      'read and save reagent name
 0B2F   004A            CLOSE #1
 0B36   004A
 0B36   004A            OPEN "READIR.RJP" FOR INPUT AS #1
 0B47   004A            INPUT #1,REANUM%:'      read number of reagents
 0B59   004A            MESSAGE$ = "Reading Reagent Directory  Please Wait"
 0B6J   004A            GOSUB MESSAGE.ON
 0B69   004A            FLAG% = 0
 0B70   004A            TEMP% = REANUM% - 1:IF REANUM% < 80 THEN TEMP% = REANUM
                %
 0B8B   004C            FOR I% = 0 TO TEMP%
 0B97   004E                    LOCATE (I% MOD 20)+1,(INT(I%/20)*20)+1
 0BCA   004E                    PRINT SPACE$(18);
 0BDA   004E            NEXT I%
 0BEC   004E
 0BEC   004E            FOR I% = 0 TO REANUM% - 1
 0BFA   0050                    INPUT #1,REANAME$
 0C0C   0050                    LOCATE (I% MOD 20)+1,(INT(I%/20)*20)+3
 0C3F   0050                    PRINT REANAME$;
 0C4C   0050                    IF REANAME$ = SELNAME$ THEN LOCATE (I% MOD 20)+
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

                I,(INT(I%/20)*20)+1:PRINT "*";
 0C9B   0050            NEXT I%
 0CB0   0050            CLOSE #1
 0CB7   0050            GOSUB MESSAGE.OFF
 0CBD   0050            RETURN
 0CC1   0050
 0CC1   0050    INITIALIZE:
 0CC6   0050            DIM MENU$(4,1)
 0CC7   0078            MENU$(0,0) = "Delete"
 0CDF   0078            MENU$(0,1) = "Remove a reagent file from the directory"
 0CFA   0078            MENU$(1,0) = "Copy"
 0D15   0078            MENU$(1,1) = "Copy a reagent file to a new reagent name
                "
 0D2E   0078            MENU$(2,0) = "Rename"
 0D4B   0078            MENU$(2,1) = "Rename a reagent file in the directory"
 0D69   0078            MENU$(3,0) = "Select"
 0D84   0078            MENU$(3,1) = "Select a reagent file to be printed"
 0DA0   0078            MENU$(4,0) = "Exit"
 0DBB   0078            MENU$(4,1) = "Return to the main menu"
 0DD7   0078
 0DD7   0078            COLOR 9,0:CLS
 0DEA   0078            LOCATE 21,1
 0DF7   0078            FOR I% = 1 TO 80
 0DFE   0078                    PRINT "D";
 0E0B   0078            NEXT I%
 0E1B   0078
 0E1B   0078            FOR MENU% = 0 TO 4
 0E21   0078                    GOSUB MENU.OFF
 0E27   0078            NEXT MENU%
 0E37   0078
 0E37   0078            GOSUB DISP.DIR
 0E3D   0078            IF FLAG% > 0 THEN GOSUB SHOW.ERROR
 0E4E   0078            MENU% = 4
 0E55   0078            GOSUB MENU.ON
 0E5B   0078
 0E5B   0078            RETURN
 0E5F   0078
 0E5F   0078    NEW.MENU:
 0E64   0078            GOSUB MENU.OFF
 0E6A   0078            MENU% = MENU% + DIFF%
 0E76   0078            GOSUB MENU.ON
 0E7C   0078            RETURN
 0E80   0078
 0E80   0078    MENU.ON:
 0E85   0078            LOCATE 22,(MENU%*10)+18
 0E9C   0078            COLOR 0,7
 0EAB   0078            PRINT MENU$(MENU%,0);
 0EC6   0078            LOCATE 25,40-LEN(MENU$(MENU%,1))/2
 0EFA   0078            COLOR 7,0
 0F06   0078            PRINT MENU$(MENU%,1);
 0F25   0078            RETURN
 0F29   0078
 0F29   0078    MENU.OFF:
 0F2E   0078            LOCATE 22,(MENU%*10)+18
```

```
Reagent Jet Printer                                                    PAGE  13
Reagent Filing                                                         07-09-86
                                                                       15:04:35
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00
5
 0F45   0078            COLOR 14,0
 0F51   0078            PRINT MENU$(MENUX,0);
 0F6F   0078            LOCATE 25,40-LEN(MENU$(MENUX,1))/2
 0FA3   0078            PRINT SPACE$(LEN(MENU$(MENUX,1)));
10       0FCB   0078            RETURN
 0FCC   0078
 0FCC   0078    SHOW.ERROR:
 0FD1   0078            ON FLAGX GOSUB ER1, ER2, ER3, ER4
 0FE2   0078            ERRMSG$ = ERR$ + "     Strike any key.."
15       0FF2   0080            LOCATE 24,40-LEN(ERRMSG$)/2
 1014   0080            COLOR 13,0
 1020   0080            PRINT ERRMSG$;
 102D   0080            A$ = ""
 1037   0080            WHILE A$ = ""
20       1046   0080                    A$ = INKEY$
 1050   0080            WEND
 1053   0080            GOSUB MESSAGE.OFF
 1059   0080            RETURN
 105D   0080
25       105D   0080    ER1:
 1062   0080            ERR$ = REANAME$ + " Not Found in the Directory"
 1072   0080            RETURN
 1076   0080
 1076   0080    ER2:
30       107B   0080            ERR$ = "Reagent Name is too Long (15 characters max.)"
 1085   0080            RETURN
 1089   0080
 1089   0080    ER3:
 108E   0080            ERR$ = "Directory is Full (60 reagents max.)"
35       1098   0080            RETURN
 109C   0080
 109C   0080    ER4:
 10A1   0080            ERR$ = "Cannot Modify SELECTd reagent Name"
 10AB   0080            RETURN
40       10AF   0080
 10AF   0080    MESSAGE.ON:
 10B4   0080            LOCATE 24,38 - LEN(MESSAGE$) / 2:COLOR 11,0:PRINT MESSA
                GE$;
 10EF   0080            RETURN
45       10F3   0080
 10F3   0080
 10F3   0080    MESSAGE.OFF:
 10F8   0080            LOCATE 24,1:COLOR 15,0:PRINT SPACE$(79);
 1121   0080            RETURN
50       1125   0080
 1125   0080    END SUB
 112C   0080
 16C9   0080

55      50426 Bytes Available
       45718 Bytes Free

     0 Warning Error(s)
     0 Severe  Error(s)
```

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
0030  0006  REM $TITLE:'Reagent Jet Printer  $SUBTITLE:'Pattern Filing'
0030  0006  'MODULE   - "PATFILE" File Handling for patterns
0030  0006  '
0030  0006  'AUTHOR   - N. A. Enevold
0030  0006  '
0030  0006  'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030  0006  '
0030  0006  'REVISION - 1.0 02-12-86 NAE Creation of initial code
0030  0006  '
0030  0006  'SYSTEM   - This code can only be compiled by the BASCOM
0030  0006  '           COMPILER, it will not run under the INTERPRETER!!
0030  0006  '
0030  0006  'DESCRIPTION:
0030  0006  '       This module allow file handling for patterns.  When inv
                oked, it displays
0030  0006  '       the current contents of the pattern directory in 4 colu
                mns of 20 entries
0030  0006  '       each.  The pattern which is currently selected for prin
                ting is marked by
0030  0006  '       an asterisk to the left of the pattern name.  After the
                 directory is listed
0030  0006  '       the user is presented with 5 menu choices.  The left an
                d right arrows are
0030  0006  '       used to highlight menu items and the enter key is used
                to invoke action.
0030  0006  '       The menu choices and their actions are:
0030  0006  '
0030  0006  '               DELETE - Remove a pattern file from the directo
                ry
0030  0006  '               COPY -   Copy a pattern file to a new pattern n
                ame, saving the old pattern
0030  0006  '               RENAME - Change the name of the pattern without
                 changing the pattern itself
0030  0006  '               SELECT - Selct a pattern for printing
0030  0006  '               EXIT -   Return to the main menu
0030  0006  '
0030  0006  'DATA DICTIONARY
0030  0006  '       TYPE%       Which type of valid key was pushed
0030  0006  '       MENU%       Which menu item is being pointer to (0-4)
0030  0006  '       DIFF%       Distance to move MENU% at left or right arro
                w
0030  0006  '       FLAG%       Error type 0-4
0030  0006  '       POINTER%    Position of PATNAME$ in directory list
0030  0006  '       PATNUM%             Number of pattern names in directory
                 list
0030  0006  '       ELNUM%      Number of elements in a pattern file
0030  0006  '       TEMP%       Storage for integers during pattern copy
0030  0006  '       I%          Counter used during pattern copy
0030  0006  '       J%          Counter used during pattern copy
0030  0006  '       A$          Misc. input string
0030  0006  '       FUNCT$      Printed at bottom of screen during prompt fo
                r pattern name
0030  0006  '       PATNAME$    Pattern name currently being worked on
0030  0006  '       SELNAME$    Pattern name currently selected for printing
```

```
Reagent Jet Printer                                                    PAGE  2
Pattern Filing                                                         07-09-86
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Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    '       FILE$       Filename of pattern data file
 0030   0006    '       SFILE$      Filename for source pattern data file used d
                uring copy
 0030   0006    '       DFILE$      Filename for destination pattern data file u
                sed during copy
 0030   0006    '       NEWNAME$    New pattern name for COPY and RENAME
 0030   0006    '       TEMP$       Pattern names are held here as the directory
                 is being re-written
 0030   0006    '       NEWFILE$    Destination filename used while copying patt
                ern data files
 0030   0006    '       MESSAGE$    A message printed at the bottom of the scree
                n
 0030   0006    '       MENU$(4,1) Array of strings containing the short and lo
                ng menu names
 0030   0006    '       ERRMSG$     Message printed when any error occurs
 0030   0006    '       ERR$        Appended to ERRMSG$ to indicate nature of er
                ror
 0030   0006    '       TEMP        Storage of real variables while copying patt
                ern data files
 0030   0006    REM $PAGE


Reagent Jet Printer                                                    PAGE  3
Pattern Filing                                                         07-09-86
                                                                       15:11:46
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    SUB PATTERN.FILE STATIC
 0047   0006
 0047   0006            GOSUB INITIALIZE
 004D   0006            TYPE% = 0
 0054   0008
 0054   0008            WHILE TYPE% <> 3
 005F   0008                    A$ = ""
 0069   000C                    WHILE A$ = ""
 0078   000C                            A$ = INKEY$
 0082   000C                    WEND
 0085   000C                    IF A$ = CHR$(0) + CHR$(75) THEN TYPE% = 1:
                'left arrow
 00AA   000C                    IF A$ = CHR$(0) + CHR$(77) THEN TYPE% = 2:
                'right arrow
 00CF   000C                    IF A$ = CHR$(13) THEN TYPE% = 3:
                '(cr) to execute selection
 00E9   000C
 00E9   000C                    ON TYPE% GOSUB T1, T2, T3
 00F8   000C            WEND
 00FC   000C
 00FC   000C            EXIT SUB
 0100   000C
 0100   000C    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE   4
Pattern Filing                                                         07-09-86
                                                                       15:11:46
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0100   000C    '******** SUB-ROUTINES FOR THIS MODULE ********
 0100   000C
 0100   000C    T1:             'left arrow
 0105   000C            TYPE% = 0
 010C   000C            IF MENU% = 0 THEN RETURN
 011B   000E            DIFF% = -1
 0122   0010            GOSUB NEW.MENU
 012B   0010            RETURN
 012C   0010
 012C   0010    T2:             'right arrow
 0131   0010            TYPE% = 0
 013B   0010            IF MENU% = 4 THEN RETURN
 0147   0010            DIFF% = 1
 014E   0010            GOSUB NEW.MENU
 0154   0010            RETURN
 015B   0010
 015B   0010    T3:             '<cr>  (execute selected menu item)
 015D   0010            LOCATE 25,1:PRINT SPACE$(79);
 017A   0010            ON MENU% + 1 GOSUB T3A, T3B, T3C, T3D, T3E
 018F   0010            GOSUB MENU.ON
 0195   0010            RETURN
 0199   0010
 0199   0010    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

0199    0010    T3A:            delete pattern
019E    0010            TYPE% = 0
01A5    0010            FUNCT$ = "Delete"
01AF    0014            GOSUB GET.SOURCE
01B5    0014            IF LEN(PATNAME$) = 0 THEN RETURN
01C7    0018            IF PATNAME$ = SELNAME$ THEN FLAG% = 4:GOSUB SHOW.ERROR:
                    RETURN
01E7    001E            GOSUB SEARCH
01ED    001E            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
0209    0020
0209    0020            MESSAGE$ = "Deleting " + PATNAME$ + "     Please Wait..
                    ."
0220    0024            GOSUB MESSAGE.ON
0226    0024
0226    0024                    'rewrite directory deleting PATNAME$ as indicat
                    ed by POINTER%
0226    0024            KILL "PATDIR.OLD"
022D    0024            NAME "PATDIR.RJP" AS "PATDIR.OLD"
0237    0024            OPEN "PATDIR.OLD" FOR INPUT AS #1
0248    0024            OPEN "PATDIR.RJP" FOR OUTPUT AS #2
025A    0024
025A    0024            INPUT #1, PATNUM%
026C    0026            PATNUM% = PATNUM% - 1
0275    0026            WRITE #2,PATNUM%
0286    0026
0286    0026            IF PATNUM% = 0 THEN GOTO DIR.DONE
0295    0026            FOR I% = 1 TO PATNUM% + 1
02A4    002B                    INPUT #1,PATNAME$
02B6    002B                    IF I% <> POINTER% THEN PRINT #2,PATNAME$
02D3    002A            NEXT I%
02E5    002A
02E5    002A    DIR.DONE:
02EA    002A            CLOSE #1:CLOSE #2
02FB    002A
02FB    002A                    'remove data file
02FB    002A            FILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER%))-1) +
                    "PAT.RJP"
031C    002E            KILL FILE$
0323    002E
0323    002E                    'rename remaining data files to maintain linked
                     list with directory
0323    002E            WHILE (PATNUM% + 1) > POINTER%
0333    002E                    SFILE$ = RIGHT$(STR$(POINTER%+1),LEN(STR$(POINT
                    ER%+1))-1) + "PAT.RJP"
0359    0032                    DFILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER
                    %))-1) + "PAT.RJP"
037D    0036                    NAME SFILE$ AS DFILE$
0387    0036                    POINTER% = POINTER% + 1
0390    0036            WEND
0393    0036
0393    0036            GOSUB MESSAGE.OFF
0399    0036            PATNAME$ = SELNAME$
03A3    0036            GOSUB T3DA
03A9    0036            GOSUB DISP.DIR
```

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Pattern Filing

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Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
03AF  0036          RETURN
03B3  0036
03B3  0036    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  7
Pattern Filing                                                         07-09-86
                                                                       15:11:46
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 03B3   0036   TSB:     'copy pattern
 03B8   0036            TYPEZ = 0
 03BF   0036            IF PATNUMZ = 80 THEN FLAGZ = 3:GOSUB SHOW.ERROR:RETURN
 03DB   0036            FUNCT$ = "Copy"
 03E5   0036            GOSUB GET.SOURCE
 03EB   0036            IF LEN(PATNAME$) = 0 THEN RETURN
 03FD   0036            GOSUB SEARCH
 0403   0036            IF POINTERZ = 0 THEN FLAGZ = 1:GOSUB SHOW.ERROR:RETURN
 041F   0036
 041F   0036            GOSUB GET.NEW.NAME
 0425   0036            IF LEN(NEWNAME$) = 0 THEN RETURN
 0437   003A            IF LEN(NEWNAME$) > 15 THEN FLAGZ = 2:GOSUB SHOW.ERROR:R
                    ETURN
 0457   003A
 0457   003A            MESSAGE$ = "Copying " + PATNAME$ + " to " + NEWNAME$ +
                    "    Please wait.."
 047C   003A            GOSUB MESSAGE.ON
 0482   003A
 0482   003A                    'add NEWNAME$ at end of directory
 0482   003A            KILL "PATDIR.OLD"
 0489   003A            NAME "PATDIR.RJP" AS "PATDIR.OLD"
 0493   003A            OPEN "PATDIR.OLD" FOR INPUT AS #1
 04A4   003A            OPEN "PATDIR.RJP" FOR OUTPUT AS #2
 04B6   003A
 04B6   003A            INPUT #1, PATNUMZ
 04C8   003A            PATNUMZ = PATNUMZ + 1
 04D1   003A            WRITE #2,PATNUMZ
 04E2   003A
 04E2   003A            FOR IZ = 1 TO PATNUMZ - 1
 04F1   003C                    INPUT #1,TEMP$
 0503   0040                    PRINT #2,TEMP$
 0513   0040            NEXT IZ
 0525   0040            PRINT #2,NEWNAME$
 0535   0040
 0535   0040            CLOSE #1:CLOSE #2
 0543   0040
 0543   0040                    'create copy of pattern data file
 0543   0040            FILE$ = RIGHT$(STR$(POINTERZ),LEN(STR$(POINTERZ))-1) +
                    "PAT.RJP"
 0567   0040            NEWFILE$ = RIGHT$(STR$(PATNUMZ),LEN(STR$(PATNUMZ))-1) +
                     "PAT.RJP"
 0588   0044
 0586   0044            OPEN FILE$ FOR INPUT AS #1
 059C   0044            OPEN NEWFILE$ FOR OUTPUT AS #2
 05AE   0044
 05AE   0044            INPUT #1,ELNUMZ
 05C0   0046            WRITE #2,ELNUMZ
 05D1   0046
 05D1   0046            FOR IZ = 1 TO 4
 05D8   0046                    INPUT #1,TEMP
 05EA   004A                    WRITE #2,TEMP
 05FA   004A            NEXT IZ
 060A   004A
 060A   004A            FOR IZ = 1 TO ELNUMZ
```


BAD ORIGINAL

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0617   004C                  FOR J% = 1 TO 6
 061E   004C                        INPUT #1,TEMP%
 0630   004E                        WRITE #2,TEMP%
 0641   004E                  NEXT J%
 0651   0050            NEXT I%
 0663   0050
 0663   0050            CLOSE #1:CLOSE #2
 0671   0050
 0671   0050            GOSUB MESSAGE.OFF
 0677   0050            GOSUB DISP.DIR
 067D   0050            RETURN
 0681   0050
 0681   0050    T3C:            'rename pattern
 0686   0050            TYPE% = 0
 068D   0050            FUNCT$ = "Rename"
 0697   0050            GOSUB GET.SOURCE
 069D   0050            IF LEN(PATNAME$) = 0 THEN RETURN
 06AF   0050            GOSUB SEARCH
 06B5   0050            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
 06D1   0050
 06D1   0050            GOSUB GET.NEW.NAME
 06D7   0050            IF LEN(NEWNAME$) = 0 THEN RETURN
 06E9   0050            IF LEN(NEWNAME$) > 15 THEN FLAG% = 2:GOSUB SHOW.ERROR:R
                    ETURN
 0709   0050            IF NEWNAME$ = PATNAME$ THEN RETURN
 071C   0050
 071C   0050            MESSAGE$ = "Renaming " + PATNAME$ + " to " + NEWNAME$ +
                     "    Please wait.."
 0741   0050            GOSUB MESSAGE.ON
 0747   0050
 0747   0050                    'change pattern name in directory replacing PAT
                    NAME$ with NEWNAME$
 0747   0050            KILL "PATDIR.OLD"
 074E   0050            NAME "PATDIR.RJP" AS "PATDIR.OLD"
 0758   0050            OPEN "PATDIR.OLD" FOR INPUT AS #1
 0769   0050            OPEN "PATDIR.RJP" FOR OUTPUT AS #2
 077B   0050
 077B   0050            INPUT #1, PATNUM%
 078D   0050            WRITE #2,PATNUM%
 079E   0050
 079E   0050            FOR I% = 1 TO PATNUM%
 07AB   0052                    INPUT #1,TEMP$
 07BD   0052                    IF I% <> POINTER% THEN PRINT #2,TEMP$
 07DA   0052                    IF I% = POINTER% THEN PRINT #2,NEWNAME$
 07F7   0052            NEXT I%
 0809   0052
 0809   0052            CLOSE #1:CLOSE #2
 0817   0052
 0817   0052            GOSUB MESSAGE.OFF
 081D   0052
 081D   0052                    'select new pattern name if necessary
 081D   0052            IF PATNAME$ = SELNAME$ THEN PATNAME$ = NEWNAME$:GOSUB T
                    3DA
 083C   0052            GOSUB DISP.DIR
```

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Reagent Jet Printer                                                    PAGE  9
Pattern Filing                                                         07-09-86
                                                                       15:11:46
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0842   0052            RETURN
 0846   0052
 0846   0052    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE 10
Pattern Filing                                                         07-09-86
                                                                       15:11:46
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0846   0052    T3D:            'select pattern for printing
 084B   0052            TYPEZ = 0
 0852   0052            FUNCT$ = "Select"
 085C   0052            GOSUB GET.SOURCE
 0862   0052            IF LEN(PATNAME$) = 0 THEN RETURN
 0874   0052            IF PATNAME$ = SELNAME$ THEN RETURN
 0887   0052            GOSUB T3DA
 088D   0052            GOSUB DISP.DIR
 0893   0052            RETURN
 0897   0052
 0897   0052    T3DA:
 089C   0052            GOSUB SEARCH
 08A2   0052            IF POINTERZ = 0 THEN FLAGZ = 1:GOSUB SHOW.ERROR:RETURN
 08BE   0052
 08BE   0052            MESSAGE$ = "Selecting " + PATNAME$ + "     Please Wait.
        ..."
 08D5   0052            GOSUB MESSAGE.ON
 08DB   0052
 08DB   0052                    'change entrys in pattern default file PATDEF.R
        JP
 08DB   0052            OPEN "PATDEF.RJP" FOR OUTPUT AS #1
 08ED   0052            FILE$ = RIGHT$(STR$(POINTERZ),LEN(STR$(POINTERZ))-1) +
        "PAT.RJP"
 0911   0052
 0911   0052            PRINT #1,FILE$
 0921   0052            PRINT #1,PATNAME$
 0931   0052
 0931   0052            CLOSE #1
 0938   0052            GOSUB MESSAGE.OFF
 093E   0052            RETURN
 0942   0052
 0942   0052    T3E:    'exit pattern filing
 0947   0052            RETURN
 094B   0052
 094B   0052    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 094B   0052    SEARCH:
 0950   0052            POINTER% = 0
 0957   0052            OPEN "PATDIR.RJP" FOR INPUT AS #1
 0968   0052            INPUT #1,PATNUM%:'      get number of patterns in direc
                tory
 097A   0052            IF PATNUM% = 0 THEN CLOSE #1:RETURN
 0990   0052            TEMP$ = ""
 099A   0052            WHILE (POINTER% < PATNUM%) AND (PATNAME$ <> TEMP$)
 09C2   0052                    LINE INPUT #1,TEMP$
 09CF   0052                    POINTER% = POINTER% + 1
 09D8   0052            WEND
 09DB   0052            IF PATNAME$ <> TEMP$ THEN POINTER% = 0
 09F1   0052            CLOSE #1
 09F8   0052            RETURN
 09FC   0052
 09FC   0052    GET.SOURCE:
 0A01   0052            LOCATE 25,1:COLOR 15,0:PRINT "Enter Pattern Name to "FU
                NCT$"  ";
 0A33   0052            LINE INPUT;"",PATNAME$
 0A41   0052            LOCATE 25,1:PRINT SPACE$(79);
 0A5E   0052            RETURN
 0A62   0052
 0A62   0052    GET.NEW.NAME:
 0A67   0052            LOCATE 25,1:COLOR 15,0:PRINT "Enter New Pattern Name ";
 0A8D   0052            LINE INPUT;"",NEWNAME$
 0A9B   0052            LOCATE 25,1:PRINT SPACE$(79);
 0AB8   0052            RETURN
 0ABC   0052
 0ABC   0052    DISP.DIR:       'display directory in 4 columns, 20 rows
 0AC1   0052                    'read default pattern name into SELNAME$
 0AC1   0052            OPEN "PATDEF.RJP" FOR INPUT AS #1
 0AD2   0052            INPUT #1,SELNAME$:      'discard data file name
 0AE4   0052            INPUT #1,SELNAME$
 0AF6   0052            CLOSE #1
 0AFD   0052
 0AFD   0052            OPEN "PATDIR.RJP" FOR INPUT AS #1
 0B0E   0052            INPUT #1,PATNUM%:'      read number of patterns
 0B20   0052
 0B20   0052            MESSAGE$ = "Reading Pattern Directory  Please Wait"
 0B2A   0052            GOSUB MESSAGE.ON
 0B30   0052            FLAG% = 0
 0B37   0052            TEMP% = PATNUM% - 1:IF PATNUM% < 80 THEN TEMP% = PATNUM
                %
 0B52   0052            FOR I% = 0 TO TEMP%
 0B5E   0054                    LOCATE (I% MOD 20)+1,(INT(I%/20)*20)+1
 0B91   0054                    PRINT SPACE$(18);
 0BA1   0054            NEXT I%
 0BB3   0054
 0BB3   0054            FOR I% = 0 TO PATNUM% - 1
 0BC1   0056                    INPUT #1,PATNAME$
 0BD3   0056                    LOCATE (I% MOD 20)+1,(INT(I%/20)*20)+3
 0C06   0056                    PRINT PATNAME$;
 0C13   0056                    IF PATNAME$ = SELNAME$ THEN LOCATE (I% MOD 20)+
                1,(INT(I%/20)*20)+1:PRINT "*";
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0C62   0056            NEXT I%
 0C77   0056            CLOSE #1
 0C7E   0056            GOSUB MESSAGE.OFF
 0C84   0056            RETURN
 0C86   0056
 0C88   0056    INITIALIZE:
 0C8D   0056            DIM MENU$(4,1)
 0C8E   007E            MENU$(0,0) = "Delete"
 0CA6   007E            MENU$(0,1) = "Remove a pattern file from the directory"
 0CC1   007E            MENU$(1,0) = "Copy"
 0CDC   007E            MENU$(1,1) = "Copy a pattern file to a new pattern name
                        "
 0CF5   007E            MENU$(2,0) = "Rename"
 0D12   007E            MENU$(2,1) = "Rename a pattern file in the directory"
 0D30   007E            MENU$(3,0) = "Select" _
 0D4B   007E            MENU$(3,1) = "Select a pattern file to be printed"
 0D67   007E            MENU$(4,0) = "Exit"
 0D82   007E            MENU$(4,1) = "Return to the main menu"
 0D9E   007E
 0D9E   007E            COLOR 9,0:CLS
 0DB1   007E            LOCATE 21,1
 0DBE   007E            FOR I% = 1 TO 80
 0DC5   007E                    PRINT "D";
 0DD2   007E            NEXT I%
 0DE2   007E
 0DE2   007E            FOR MENU% = 0 TO 4
 0DE8   007E                    GOSUB MENU.OFF
 0DEE   007E            NEXT MENU%
 0DFE   007E
 0DFE   007E            GOSUB DISP.DIR
 0E04   007E            IF FLAG% > 0 THEN GOSUB SHOW.ERROR
 0E15   007E            MENU% = 4
 0E1C   007E            GOSUB MENU.ON
 0E22   007E
 0E22   007E            RETURN
 0E26   007E
 0E26   007E    NEW.MENU:
 0E2B   007E            GOSUB MENU.OFF
 0E31   007E            MENU% = MENU% + DIFF%
 0E3D   007E            GOSUB MENU.ON
 0E43   007E            RETURN
 0E47   007E
 0E47   007E    MENU.ON:
 0E4C   007E            LOCATE 22,(MENU%*10)+18
 0E63   007E            COLOR 0,7
 0E6F   007E            PRINT MENU$(MENU%,0);
 0EBD   007E            LOCATE 25,40-LEN(MENU$(MENU%,1))/2
 0EC1   007E            COLOR 7,0
 0ECD   007E            PRINT MENU$(MENU%,1);
 0EEC   007E            RETURN
 0EF0   007E
 0EF0   007E    MENU.OFF:
 0EF5   007E            LOCATE 22,(MENU%*10)+18
 0F0C   007E            COLOR 14,0
```

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Reagent Jet Printer                                                    PAGE  13
Pattern Filing                                                         07-09-86
                                                                       15:11:46
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0F18   007E            PRINT MENU$(MENUX,0);
 0F36   007E            LOCATE 25,40-LEN(MENU$(MENUX,1))/2
 0F6A   007E            PRINT SPACE$(LEN(MENU$(MENUX,1)));
 0F8F   007E            RETURN
 0F93   007E
 0F93   007E    SHOW.ERROR:
 0F9B   007E            ON FLAGX GOSUB ER1, ER2, ER3, ER4
 0FA9   007E            ERRMSG$ = ERR$ + "     Strike any key.."
 0FB9   0086            LOCATE 24,40-LEN(ERRMSG$)/2
 0FDB   0086            COLOR 13,0
 0FE7   0086            PRINT ERRMSG$;
 0FF4   0086            A$ = ""
 0FFE   0086            WHILE A$ = ""
 100D   0086                    A$ = INKEY$
 1017   0086            WEND
 101A   0086            GOSUB MESSAGE.OFF
 1020   0086            RETURN
 1024   0086
 1024   0086    ER1:
 1029   0086            ERR$ = PATNAME$ + " Not Found in the Directory"
 1039   0086            RETURN
 103D   0086
 103D   0086    ER2:
 1042   0086            ERR$ = "Pattern Name is too Long (15 characters max.)"
 104C   0086            RETURN
 1050   0086
 1050   0086    ER3:
 1055   0086            ERR$ = "Directory is Full (80 patterns max.)"
 105F   0086            RETURN
 1063   0086
 1063   0086    ER4:
 1068   0086            ERR$ = "Cannot Modify SELECTd pattern Name"
 1072   0086            RETURN
 1076   0086
 1076   0086    MESSAGE.ON:
 107B   0086            LOCATE 24,38 - LEN(MESSAGE$) / 2:COLOR 11,0:PRINT MESSA
                GE$;
 10B6   0086            RETURN
 10BA   0086
 10BA   0086
 10BA   0086    MESSAGE.OFF:
 10BF   0086            LOCATE 24,1:COLOR 15,0:PRINT SPACE$(79);
 10EB   0086            RETURN
 10EC   0086
 10EC   0086    END SUB
 10F3   0086
 1688   0086

50426 Bytes Available
45670 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

```
Reagent Jet Printer                                                    PAGE  1
Main Line Code                                                         07-09-86
                                                                       15:27:04
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

0030    0006    REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Main Line Code'
0030    0006
0030    0006    'MODULE   - "MAIN"
0030    0006
0030    0006    'AUTHOR   - N. A. Enevold
0030    0006
0030    0006    'COPYRIGHT (C) 1986 ABBOTT LABORATORIES
0030    0006
0030    0006    'REVISION - 1.1 02-19-86 NAE Add notes and revise TYPE% resetin
                g
0030    0006    '         - 1.0 02-14-86 NAE Creation of initial code
0030    0006
0030    0006    'SYSTEM   - This code can only be compiled by the BASCOM
0030    0006    '           COMPILER, it will not run under the INTERPRETER!!
0030    0006
0030    0006    'DESCRIPTION
0030    0006    '       This is the main controlling module for the Reagent Jet
                 Printer.
0030    0006    '       It displays a menu in table form that allows 6 function
                s to be
0030    0006    '       selected.  PATTERN DEFINITION allows the user to define
                 patterns
0030    0006    '       to be printed.  PATTERN FILING lets the user delete, co
                py, rename
0030    0006    '       and select patterns for printing.  REAGENT CALIBRATION
                permits setting
0030    0006    '       of operation parameters for different reagents.  REAGEN
                T FILING is
0030    0006    '       the same as pattern filing.  PRINTING PRINT prints the
                selected
0030    0006    '       pattern with the selected reagent.  SYSTEM EXIT TO DOS
                ends the session.
0030    0006    '       Using up and down arrow keys let the user move through
                the menu and
0030    0006    '       the Enter <cr> key activates the selection.
0030    0006
0030    0006    'DATA DICTIONARY
0030    0006    '       MENU%           This value represents the current menu
                item (0-5)
0030    0006    '       MENU$(5,1)      String array for displaying menu items.
                  6 rows by 2 columns
0030    0006    '                       Each row corresponds to a menu item (0-
                5)
0030    0006    '                       First column is short menu name in high
                lighted area
0030    0006    '                       Second column is long description displ
                ayed at menu bottom
0030    0006    '       MROW%(5)        This array stores to row in which the s
                hort menu name will be displayed
0030    0006    '       DIFF%           This value is used it change MENU% in r
                esponse to arrow keys
0030    0006    '       TYPE%           This value is set based on which valid
                key is pressed
0030    0006    '                       0 = No valid key.  1 = Up Arrow.  2 = D
```

```
Reagent Jet Printer                                                    PAGE  2
Main Line Code                                                         07-09-86
                                                                       15:27:04
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

                own Arrow.  3 = <cr>.
 0030   0006    '       TEMP%           Used to store MENU% while screen is ref
                reshed
 0030   0006    '       A$              Used to store single input keystrokes
 0030   0006    '       C$              Used to store special graphics characte
                rs used in drawing the menu table
 0030   0006    '       I%              Counter used to refresh display
 0030   0006    '       R%              Row in which special graphics character
                 is displayed
 0030   0006    '       C%              Column in which special graphics charac
                ter is displayed
 0030   0006    REM $PAGE


Reagent Jet Printer                                                    PAGE  3
Main Line Code                                                         07-09-86
                                                                       15:27:04
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006
 0030   0006    'Main-line code for RJP Reagent Jet Printer
 0030   0006
 0030   0006    MAIN.LINE.CODE:
 0030   0006
 0030   0006            GOSUB INITIALIZE
 0043   0006
 0046   0006            WHILE TYPE% <> 3
 0056   0008
 0056   0008                    TYPE% = 0
 005D   0008                    A$ = ""
 0067   000C                    WHILE A$ = ""
 0076   000C                            A$ = INKEY$
 0080   000C                    WEND
 0083   000C
 0083   000C                    IF A$ = CHR$(0) + CHR$(72) THEN TYPE% = 1:'
                up arrow
 00A8   000C                    IF A$ = CHR$(0) + CHR$(80) THEN TYPE% = 2:'
                down arrow
 00CD   000C                    IF A$ = CHR$(13) THEN TYPE% = 3:'
                <cr> execute command
 00E7   000C
 00E7   000C                    ON TYPE% GOSUB T1, T2, T3
 00F6   000C
 00F6   000C            WEND
 00FA   000C
 00FA   000C            CLS
 0101   000C            COLOR 7,0,0
 0112   000C            SYSTEM
 0116   000C
 0116   000C    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0116   000C    '******** SUB-ROUTINES FOR MAIN PROGRAM
 0116   000C    T1:     'up arrow
 011B   000C            IF MENUZ = 0 THEN RETURN
 012A   000E            DIFFZ = -1
 0131   0010            GOSUB NEW.MENU
 0137   0010            RETURN
 013B   0010
 013B   0010    T2:     'down arrow
 0140   0010            IF MENUZ = 5 THEN RETURN
 014F   0010            DIFFZ = 1
 0156   0010            GOSUB NEW.MENU
 015C   0010            RETURN
 0160   0010
 0160   0010    T3:
 0165   0010            ON MENUZ + 1 GOSUB T31, T32, T33, T34, T35, T36
 017C   0010            IF MENUZ < 5 THEN TYPEZ = 0:'   reset TYPEZ so progra
                    won't end
 018E   0010            SCREEN 0,0,3,3
 01A5   0010            RETURN
 01A9   0010
 01A9   0010    T31:    'pattern definition
 01AE   0010            CALL PATENTRY:          'in module PATENT
 01BA   0010            GOSUB REFRESH
 01C0   0010            RETURN
 01C4   0010
 01C4   0010    T32:    'pattern filing
 01C9   0010            SCREEN 0,0,0,0:CLS
 01E5   0010            CALL PATTERN.FILE:      'in module PATFILE
 01F1   0010            RETURN
 01F5   0010
 01F5   0010    T33:    'reagent calibration
 01FA   0010            CALL REAGENT.CALIBRATE:'in module REACAL
 0206   0010            RETURN
 020A   0010
 020A   0010    T34:    'reagent filing menu
 020F   0010            SCREEN 0,0,0,0:CLS
 022B   0010            CALL REAGENT.FILE:      'in module REAFILE
 0237   0010            RETURN
 023B   0010
 023B   0010    T35:    'print pattern
 0240   0010            CALL PATPRINT:          'in module PATPRINT
 024C   0010            RETURN
 0250   0010
 0250   0010    T36:    'exit system, don't reset TYPEZ
 0255   0010            RETURN
 0259   0010
 0259   0010    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE   5
Main Line Code                                                         07-09-86
                                                                       15:27:04
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0259   0010    NEW.MENU:
 025E   0010            GOSUB MENU.OFF
 0264   0010            MENU1 = MENU2 + DIFF1
 0270   0010            GOSUB MENU.ON
 0276   0010            RETURN
 027A   0010
 027A   0010    INITIALIZE:
 027F   0010            CALL PCI.INIT
 028B   0010
 028B   0010    '       define and initialize arrays
 028B   0010            DIM MROW%(5)
 028C   001C            MROW%(0) = 4
 029E   001C            MROW%(1) = 6
 02B1   001C            MROW%(2) = 10
 02C4   001C            MROW%(3) = 12
 02D7   001C            MROW%(4) = 16
 02EA   001C            MROW%(5) = 20
 02FD   001C
 02FD   001C            DIM MENU$(5,1)
 02FE   004C            RESTORE MENU.STRING.DATA
 0305   004C            FOR I% = 0 TO 5
 030B   004C                    READ MENU$(I%,0),MENU$(I%,1)
 033B   004E            NEXT I%
 034B   004E
 034B   004E    '       set initial values into variables
 034B   004E            TYPE% = 0
 0352   004E            MENU% = 0
 0359   004E
 0359   004E    REFRESH: 'redraw screen and highlight current menu selection
 035E   004E
 035E   004E            SCREEN 0,0,0,0:CLS:COLOR 7,0,0
 038B   004E            LOCATE 10,32:PRINT "Loading Menu....."
 03A5   004E            SCREEN 0,0,3,0:CLS
 03C2   004E
 03C2   004E
 03C2   004E            COLOR 13,0
 03CE   004E            LOCATE 1,31
 03DB   004E            PRINT "REAGENT JET PRINTER";
 03E8   004E            COLOR 10,0
 03F4   004E            LOCATE 5,26
 0401   004E            PRINT "PATTERN"
 040E   004E            LOCATE 11,26
 041B   004E            PRINT "REAGENT"
 0428   004E            LOCATE 16,26
 0435   004E            PRINT "PRINTING"
 0442   004E            LOCATE 20,27
 044F   004E            PRINT "SYSTEM"
 045C   004E
 045C   004E    '       draw the menu table in special graphics characters
 045C   004E            COLOR 9,0
 046B   004E            FOR I% = 18 TO 63
 046F   004E                    LOCATE 2,I%:PRINT "D";
 048A   004E                    LOCATE 8,I%:PRINT "D";
 04A5   004E                    LOCATE 14,I%:PRINT "D";
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 04C0   004E                 LOCATE 18,I%:PRINT "D";
 04DB   004E                 LOCATE 22,I%:PRINT "D";
 04F6   004E                 LOCATE 24,I%:PRINT "D";
 0511   004E           NEXT I%
 0524   004E           FOR I% = 3 TO 23
 052B   004E                 LOCATE I%,17:PRINT "3";
 0546   004E                 LOCATE I%,64:PRINT "3";
 0561   004E           NEXT I%
 0571   004E           RESTORE TABLE
 0578   004E           FOR I% = 1 TO 12
 057F   004E                 READ R%,C%,C$
 0592   0056                 LOCATE R%,C%:PRINT C$;
 05AE   0056           NEXT I%
 05BE   0056
 05BE   0056           ' print the instructions
 05BE   0056           COLOR 7,0
 05CA   0056           LOCATE 25,6
 05D7   0056           PRINT "Use   or   to highlight menu items.  Use     to
                     activate selection.";
 05E4   0056
 05E4   0056           COLOR 15,0
";
 060A   0056           LOCATE 25,15:PRINT "";
 0624   0056           LOCATE 25,47:PRINT "DY";
 063E   0056
 063E   0056           ' display the 6 menu choices
 063E   0056           TEMP% = MENU%
 0645   0058           FOR MENU% = 0 TO 5
 064B   0058                 GOSUB MENU.OFF
 0651   0058           NEXT MENU%
 0661   0058           MENU% = TEMP%
 0668   0058
 066B   0058           ' highlight the currently active menu item
 066B   0058           GOSUB MENU.ON
 066E   0058
 066E   0058           SCREEN 0,0,3,3
 0685   0058           RETURN
 0689   0058
 0689   0058     MENU.ON:'highlight the menu MENU% and display its long descript
                     ion
 068E   0058           COLOR 0,7
 069A   0058           LOCATE MROW%(MENU%),52-LEN(MENU$(MENU%,0))/2
 06DA   0058           PRINT MENU$(MENU%,0);
 06F6   0058           COLOR 7,0
 0704   0058           LOCATE 23,40.5-LEN(MENU$(MENU%,1))/2
 0738   0058           PRINT MENU$(MENU%,1);
 0757   0058           RETURN
 075B   0058
 075B   0058     MENU.OFF:'un-highlight menu MENU% and erase long description
 0760   0058           COLOR 14,0
 076C   0058           LOCATE MROW%(MENU%),52-LEN(MENU$(MENU%,0))/2
 07AC   0058           PRINT MENU$(MENU%,0);
 07CA   0058           COLOR 7,0
 07D6   0058           LOCATE 23,40.5-LEN(MENU$(MENU%,1))/2
```

```
Reagent Jet Printer                                                PAGE   7
Main Line Code                                                     07-09-86
                                                                   15:27:04
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 060A   005B            PRINT SPACE$(LEN(MENU$(MENUX,1)));
 062F   005B            RETURN
 0633   005B
 0633   005B    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  8
Main Line Code                                                         07-09-86
                                                                       15:27:04
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0833   0058    '******** DATA FIELDS USED BY THE MAIN PROGRAM ********
 0833   0058
 0833   0058    MENU.STRING.DATA:       'first entry is menu name, second is lo
                ng description
 0838   0058
 0838   0058            DATA "DEFINITION", "Create and Modify Patterns"
 083A   0058            DATA "FILING",     "Delete, Copy, Rename, and Select Pa
                tterns"
 083C   0058            DATA "CALIBRATION","Calibrate and Modify Reagent Profil
                es"
 083E   0058            DATA "FILING",     "Delete, Copy, Rename, and Select Re
                agents"
 0840   0058            DATA "PRINT",      "Print Selected Pattern with Selecte
                d Reagent"
 0842   0058            DATA "EXIT TO DOS","Leave Program and Return to DOS"
 0844   0058
 0844   0058    TABLE:  'first entry is row, second is column, third is special
                 graphics character
 0849   0058
 0849   0058            DATA 2,17,"Z"
 084B   0058            DATA 2,64,"?"
 084D   0058            DATA 8,17,"C"
 084F   0058            DATA 8,64,"4"
 0851   0058            DATA 14,17,"C"
 0853   0058            DATA 14,64,"4"
 0855   0058            DATA 18,17,"C"
 0857   0058            DATA 18,64,"4"
 0859   0058            DATA 22,17,"C"
 085B   0058            DATA 22,64,"4"
 085D   0058            DATA 24,17,"8"
 085F   0058            DATA 24,64,"Y"
 0861   0058
 0861   0058            END
 0865   0058
 0B42   0058

50476 Bytes Available
47680 Bytes Free

     0 Warning Error(s)
     0 Severe  Error(s)
```

Claims

1. A dispensing system for use in diagnostic instruments for precise metering of a desired diagnostic fluid, the system comprising:

a jetting chamber defining a volume and comprising a first and second aperture, the first aperture adapted to receive diagnostic fluid, the second aperture defining an orifice;

a transducer in mechanical communication with the jetting chamber, the transducer operative to alternately expand and de-expand the volume of the jetting chamber in response to a selected electrical pulse and

thereby cause the jetting chamber to omit a substantially uniformly sized droplet of diagnostic fluid through the orifice; and

means for generating a number of electrical pulses sufficient to cause a desired quantity of the diagnostic fluid to be dispensed.

2. The invention of Claim 1 wherein the system further comprises:

at least one additional jetting chamber in fluid communication with an additional diagnostic fluid;

at least one additional transducer in mechanical communication with the additional jetting chamber;

at least one additional means for applying an electrical pulse to the additional transducer;

means for generating respective numbers of electrical pulses sufficient to cause precise quantities of the diagnostic fluids to be dispensed in a desired volumetric ratio; and

a receptacle adapted for and positioned to receive the fluids.

3. The invention of Claim 1 wherein the system further comprises:

means for directing at least one of (1) the receptacle and (2) the emitted diagnostic fluid and the emitted addi-tional diagnostic fluid such that desired quantities of the fluids are dispensed into the receptacle in a predefined dispensing order.

4. The invention of Claim 1 wherein one of the diagnostic fluids comprises serum and wherein the jetting chambers cooperate such that the other diagnostic fluid is emitted in a manner to contact and mix with the serum.

5. The invention of Claim 1 wherein the jetting chamber comprises a cylindrical tube and wherein the trans-ducer is mounted concentrically about the cylindrical tube.

6. The invention of Claim 1 wherein the jetting chamber is conically shaped.

7. The invention of Claim 1 wherein the jetting chamber comprises at least one chamber wall which is integrally formed with the transducer.

8. The invention of Claim 1 wherein the transducer is one of (1) a piezo-electric transducer; (2) a magneto-strictive transducer; (3) an electro-strictive transducer; and (4) an electro-mechanical transducer.

9. The invention of Claim 1 wherein the jetting chamber is conically shaped; and wherein the transducer is disc shaped and forms the base of the conically shaped jetting chamber.

10. The invention of Claim 1 wherein the orifice comprises an end face and the end face is coated with a hydrophobic polymer.

11. The invention of Claim 1 wherein the transducer is cylindrically shaped and comprises a first electrode located on the inner wall of the cylinder and wraps around one end of the cylinder and wherein a second electrode is located substantially on the outer wall of the cylinder and is electrically isolated from the first electrode.

12. The invention of Claim 1 wherein the means for generating produces an electrical pulse of selected rise and fall time constants and of selected duration, voltage and polarity.

13. The invention of Claim 1 wherein the means for generating the electrical pulse comprises means for scaling the voltage of the pulse in response to a selectable digital value.

14. The invention of Claim 1 wherein the apparatus further comprises means for directing the emitted diagnostic fluid along a desired path.

15. A method of dispensing precise quantities of diagnostic fluids comprising the steps of:

(a) generating an electrical pulse of predefined characteristics;

(b) reducing the volume of a chamber containing the diagnostic fluid by electro-mechanical means in response to the electrical pulse such that a droplet of fluid of known volume is propelled through an orifice in the chamber; and

(c) repeating steps (a) and (b) until a desired quantity of the diagnostic fluid has been dispensed

FIG. 1

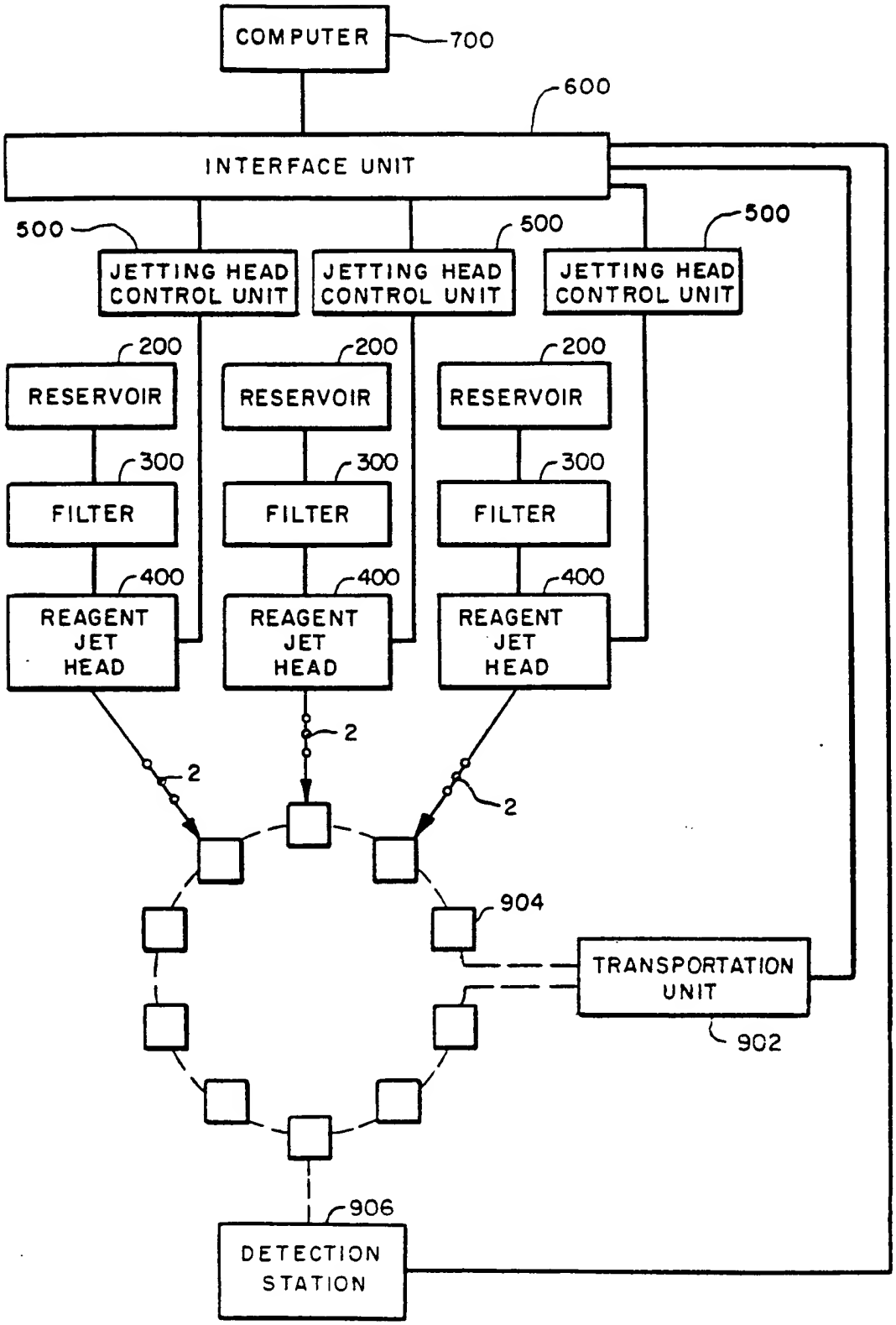

COMPUTER
700
600
INTERFACE UNIT
500
500
500
JETTING HEAD CONTROL UNIT
JETTING HEAD CONTROL UNIT
JETTING HEAD CONTROL UNIT
200
200
200
RESERVOIR
RESERVOIR
RESERVOIR
300
300
300
FILTER
FILTER
FILTER
400
400
400
REAGENT JET HEAD
REAGENT JET HEAD
REAGENT JET HEAD
2
2
2
904
TRANSPORTATION UNIT
902
906
DETECTION STATION

FIG. 2a

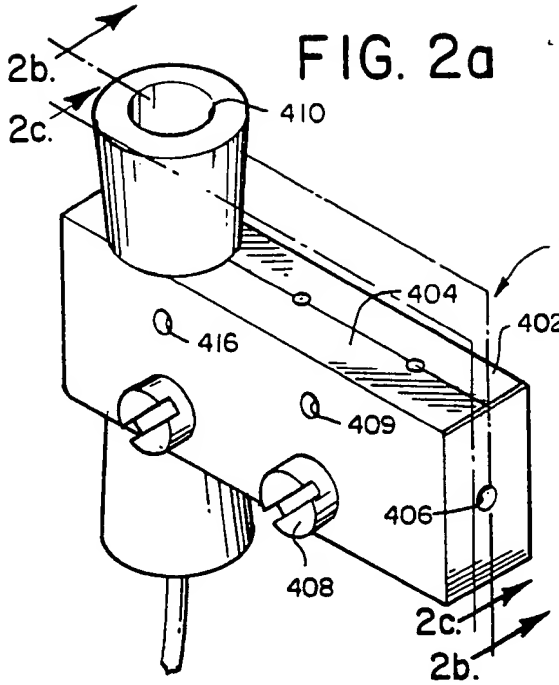


FIG. 2b

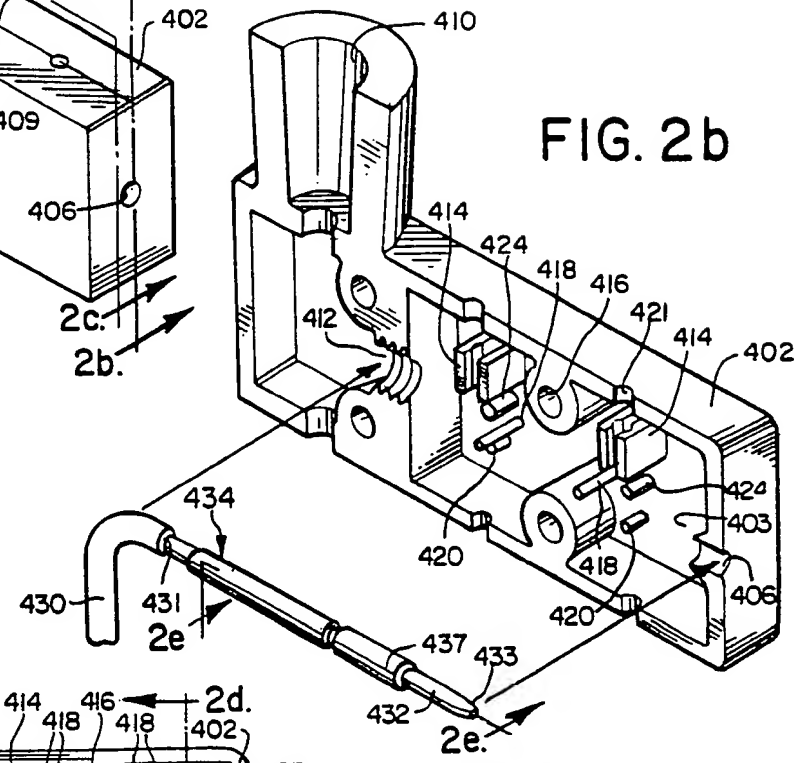
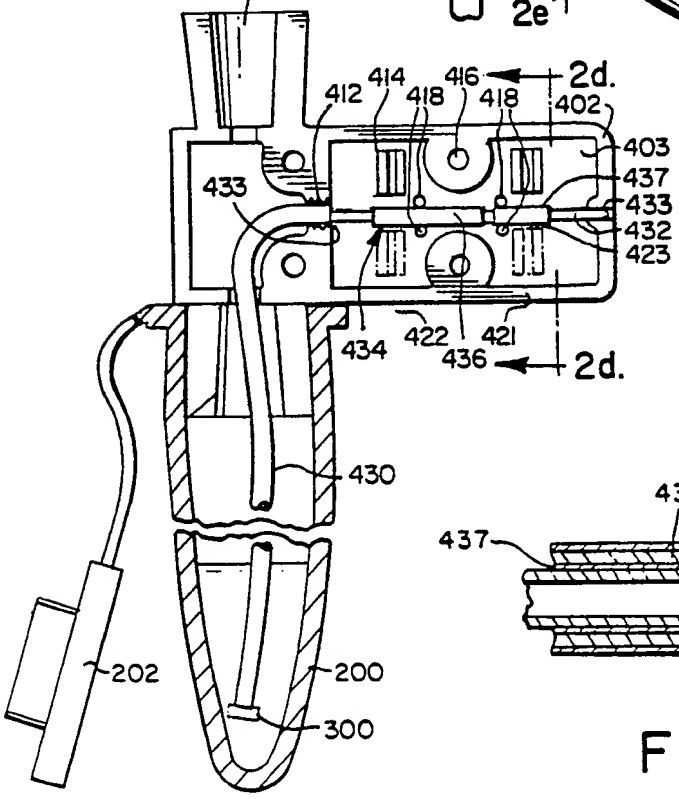


FIG. 2c



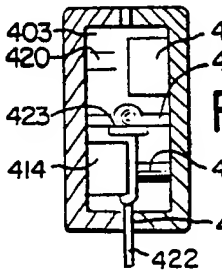


FIG. 2d

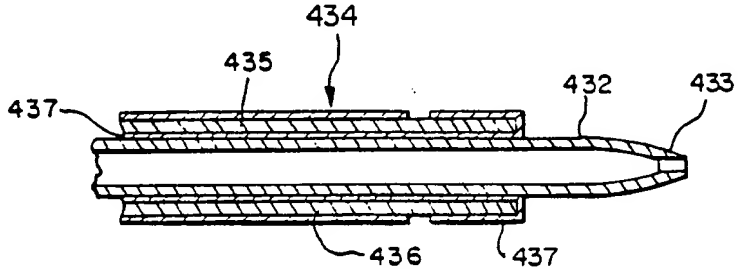
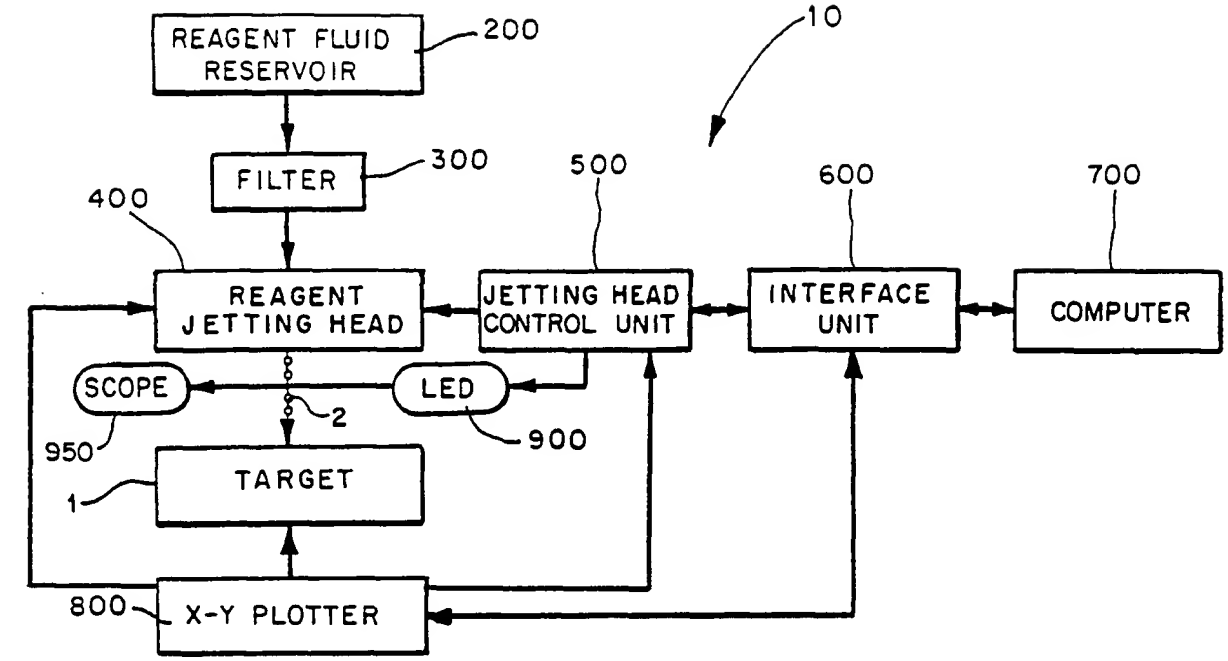


FIG. 2e

FIG. 3


REAGENT FLUID RESERVOIR
200
10
FILTER
300
500
600
700
400
REAGENT JETTING HEAD
JETTING HEAD CONTROL UNIT
INTERFACE UNIT
COMPUTER
SCOPE
LED
2
950
900
TARGET
1
800
X-Y PLOTTER

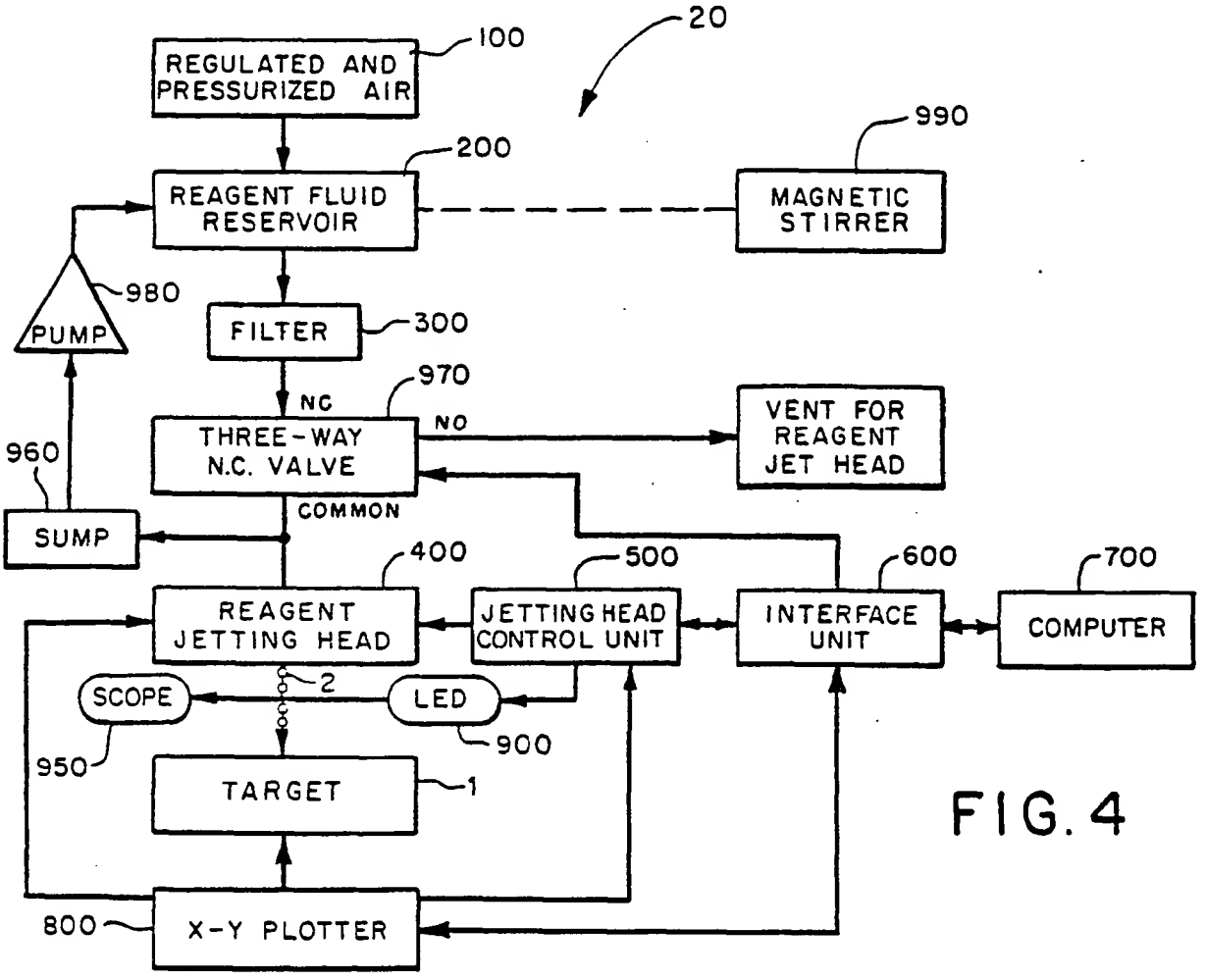

20
REGULATED AND PRESSURIZED AIR
100
990
200
REAGENT FLUID RESERVOIR
MAGNETIC STIRRER
980
PUMP
FILTER
300
970
NC
NO
THREE-WAY N.C. VALVE
VENT FOR REAGENT JET HEAD
960
COMMON
SUMP
400
500
600
700
REAGENT JETTING HEAD
JETTING HEAD CONTROL UNIT
INTERFACE UNIT
COMPUTER
SCOPE
LED
2
950
900
TARGET
1
800
X-Y PLOTTER

FIG. 4

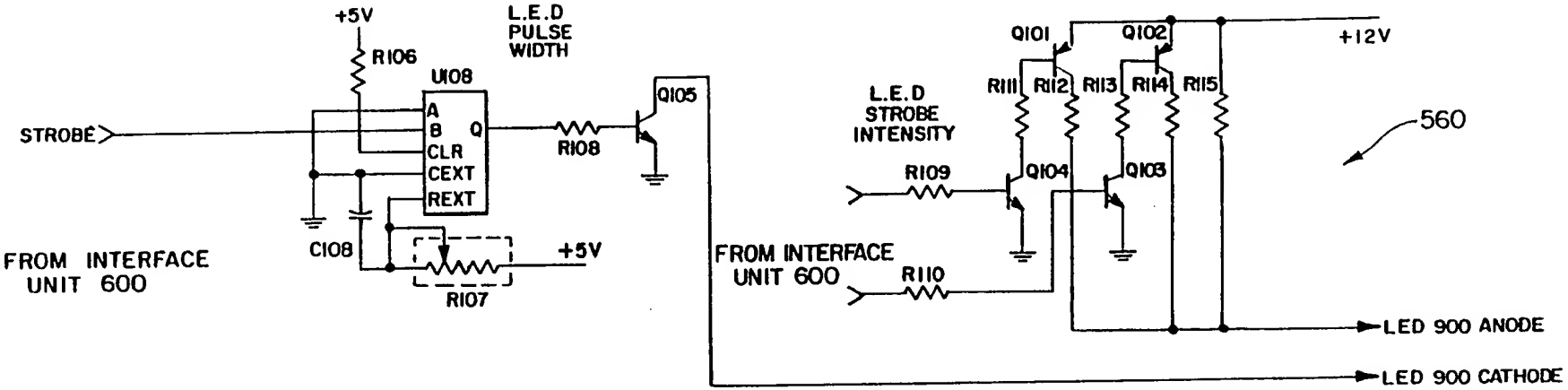

+5V
L.E.D
PULSE
WIDTH
R106
U108
A
B
Q
CLR
CEXT
REXT
Q105
STROBE
R108
C108
+5V
R107
FROM INTERFACE
UNIT 600
Q101
Q102
+12V
L.E.D
STROBE
INTENSITY
R111
R112
R113
R114
R115
560
R109
Q104
Q103
FROM INTERFACE
UNIT 600
R110
LED 900 ANODE
LED 900 CATHODE

FIG. 5a

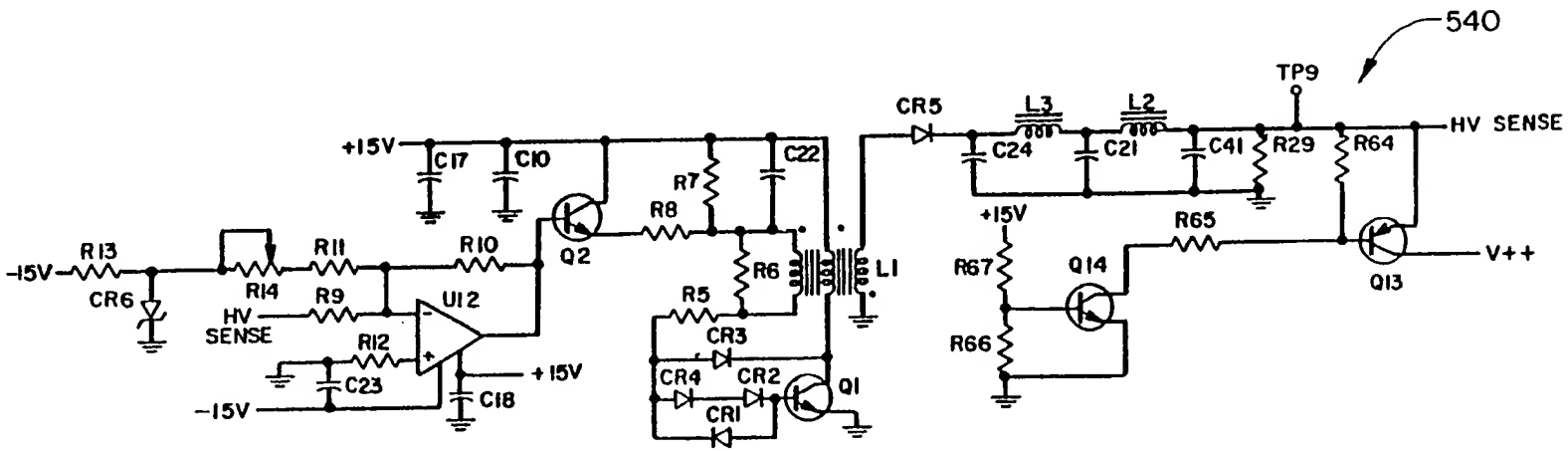

540
TP9
CR5
L3
L2
HV SENSE
+15V
C17
C10
C22
C24
C21
C41
R29
R64
R7
R8
Q2
R13
R11
R10
-15V
R14
R9
U12
CR6
HV
SENSE
R6
L1
R5
CR3
R12
C23
+15V
C18
-15V
CR4
CR2
Q1
CR1
+15V
R65
R67
Q14
V++
Q13
R66

FIG. 5b

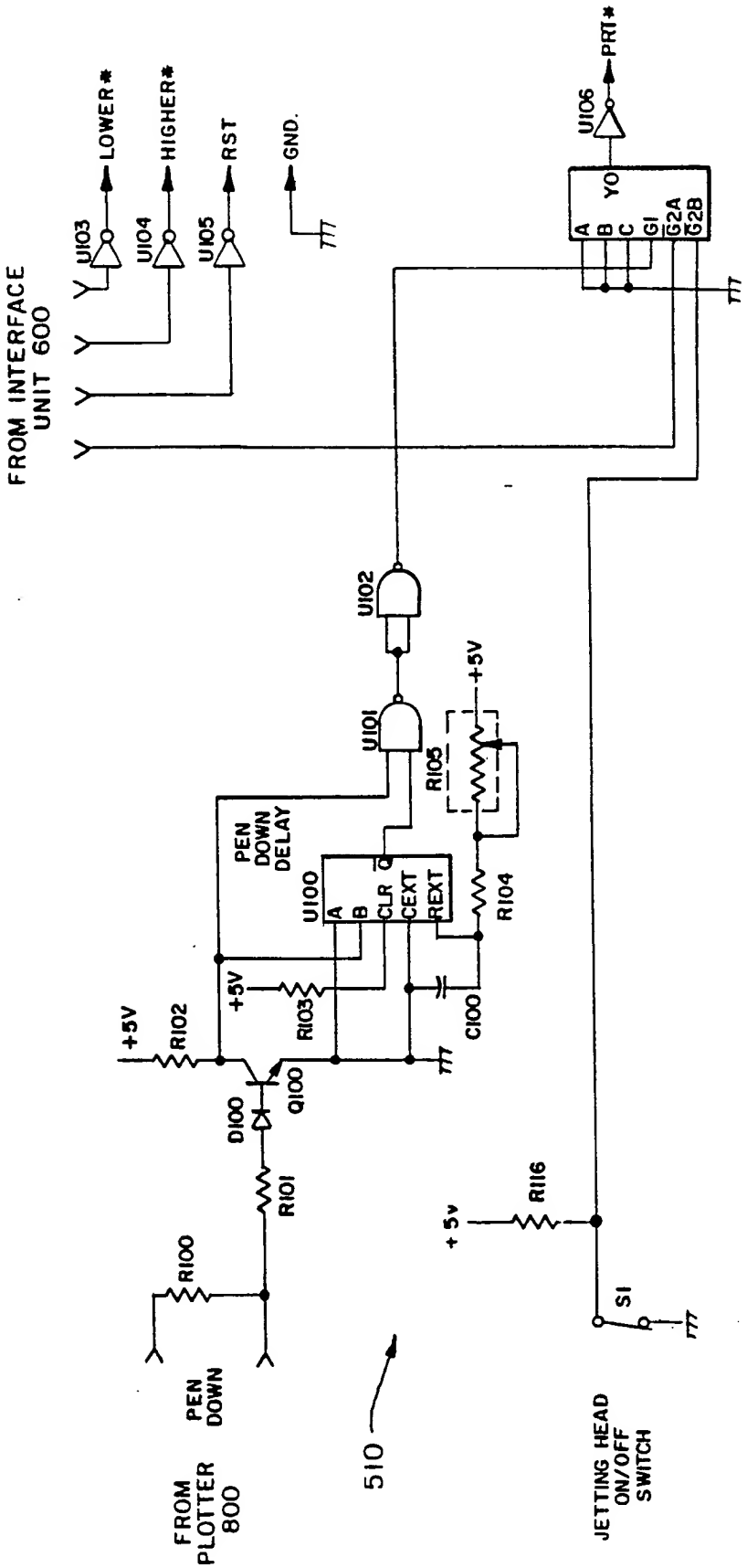

FROM INTERFACE UNIT 600
U103
U104
U105
LOWER*
HIGHER*
RST
GND.
U106
PRT*
A
B
C
G1
G2A
G2B
Y0
U102
U101
U100
PEN DOWN DELAY
CLR
CEXT
REXT
R105
R104
R103
R102
R101
R100
R116
C100
D100
Q100
+5V
S1
FROM PLOTTER 800
PEN DOWN
510
JETTING HEAD ON/OFF SWITCH

FIG. 5c

FIG. 5d

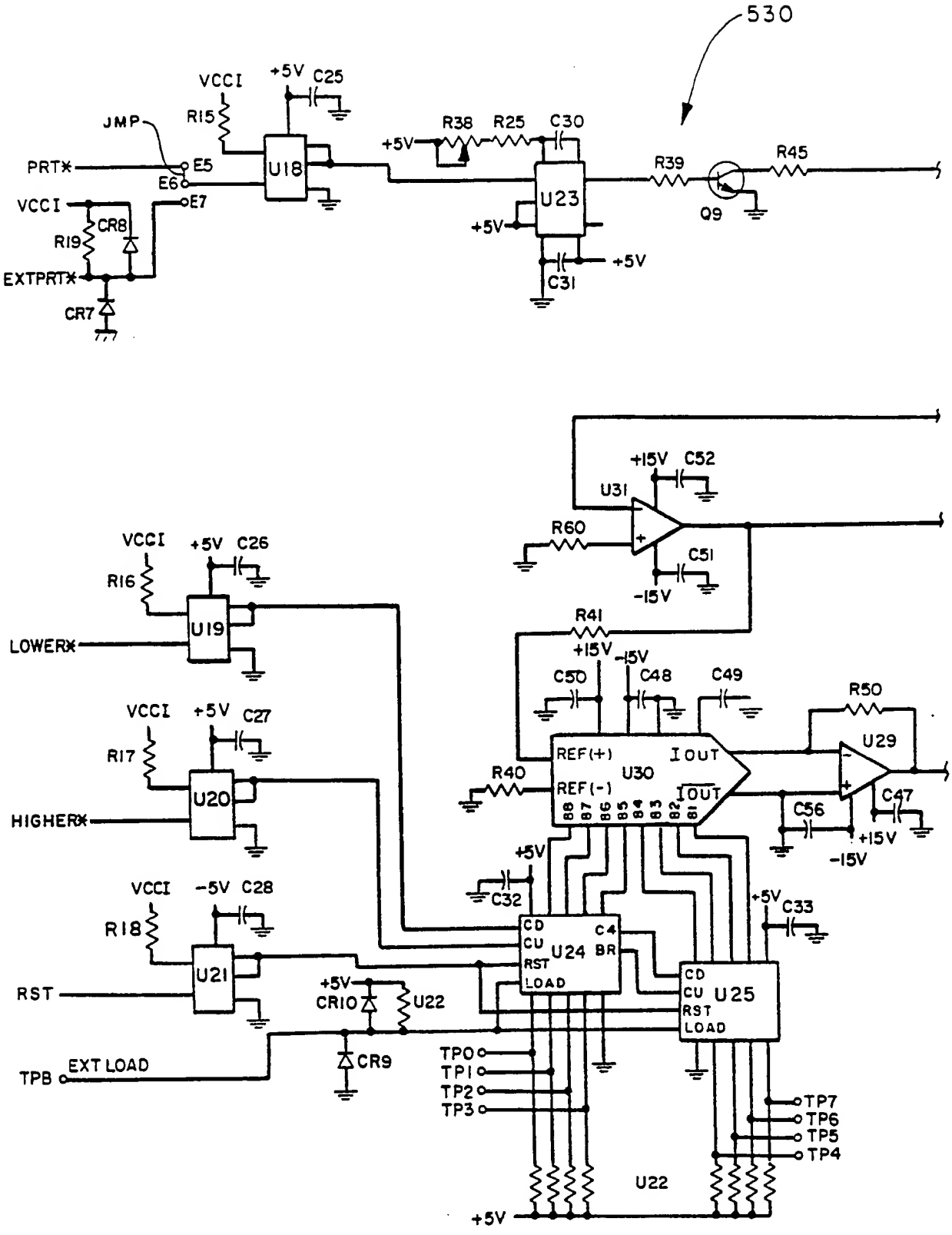

530
VCCI
+5V
C25
R15
JMP
PRT*
E5
E6
E7
U18
VCCI
CR8
R19
EXTPRT*
CR7
+5V
R38
R25
C30
U23
+5V
C31
+5V
R39
Q9
R45
+15V
C52
U31
R60
C51
-15V
R41
+15V
-15V
C50
C48
C49
R50
U29
REF(+)
REF(-)
U30
IOUT
IOUT
R40
C47
C56
+15V
-15V
VCCI
+5V
C26
R16
U19
LOWER*
VCCI
+5V
C27
R17
U20
HIGHER*
VCCI
-5V
C28
R18
U21
RST
+5V
CR10
U22
TPB
EXT LOAD
CR9
+5V
C32
+5V
C33
CD
CU
RST
LOAD
U24
C4
BR
CD
CU
RST
LOAD
U25
TP0
TP1
TP2
TP3
TP7
TP6
TP5
TP4
U22
+5V

FIG. 5e

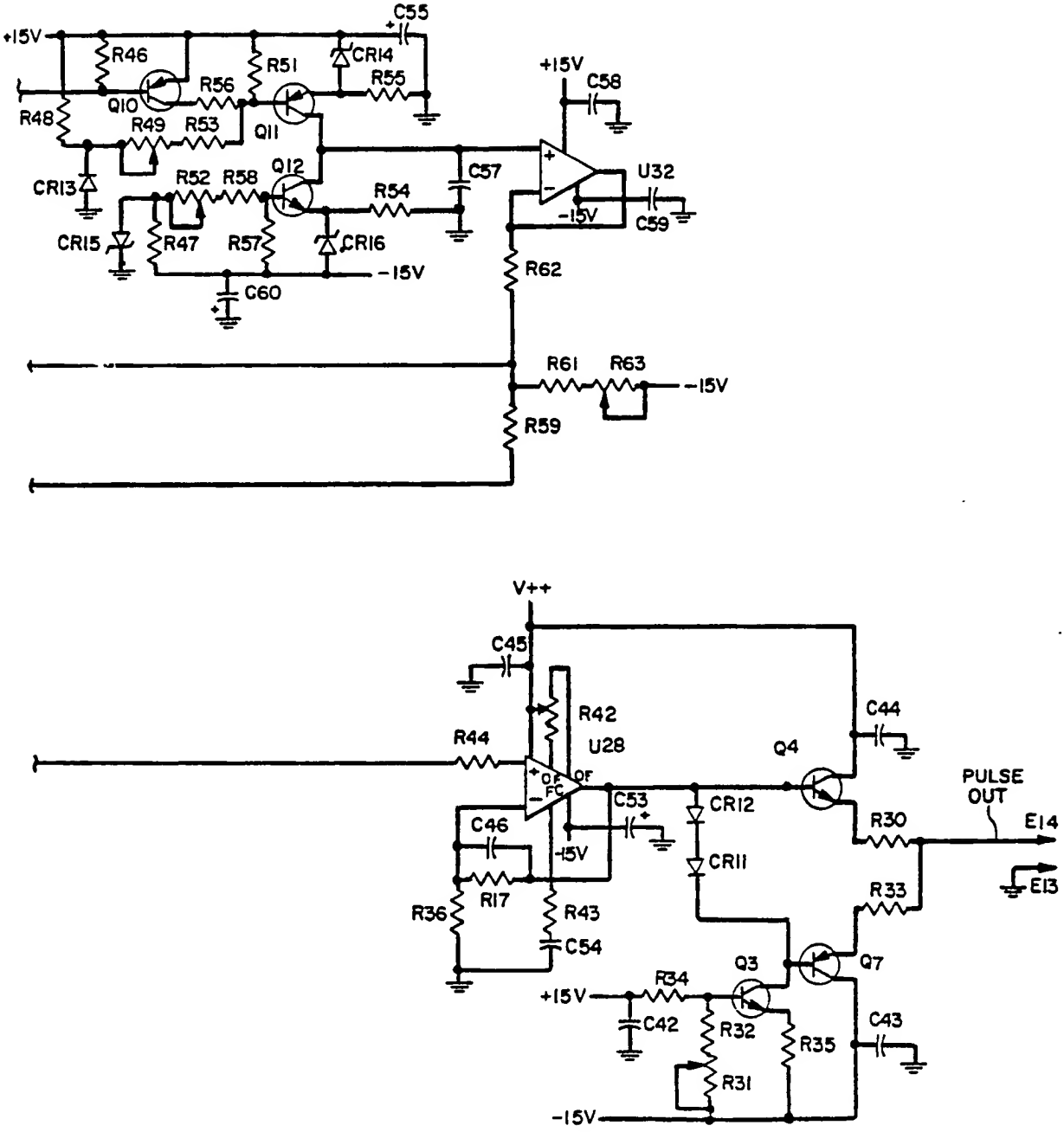

+15V
C55
R46
R51
CR14
R56
R55
Q10
Q11
R48
R49
R53
CR13
Q12
R52
R58
R54
C57
U32
+15V
C58
-15V
C59
CR15
R47
R57
CR16
-15V
C60
R62
R61
R63
-15V
R59
V++
C45
R42
R44
U28
C44
Q4
PULSE OUT
E14
C53
CR12
R30
C46
-15V
CR11
R17
R33
R36
R43
C54
Q3
Q7
R34
+15V
C42
R32
R35
C43
R31
-15V

FIG. 6a

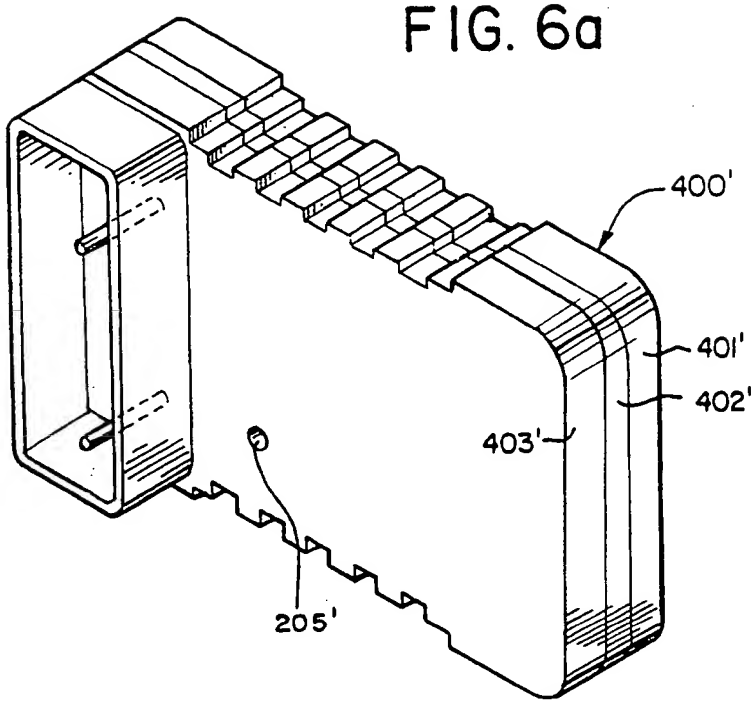


FIG. 7

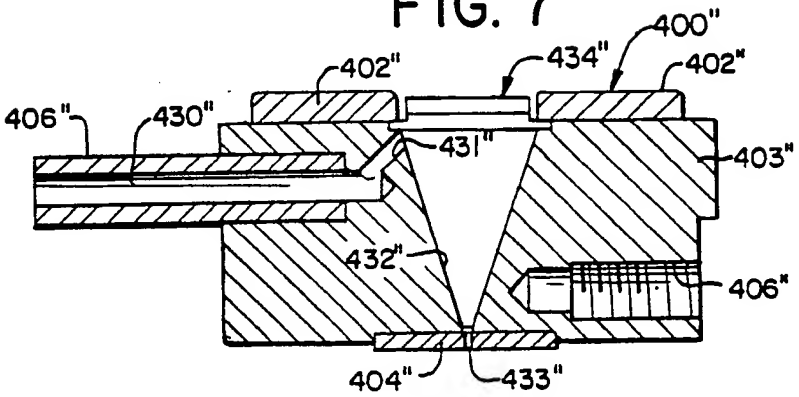
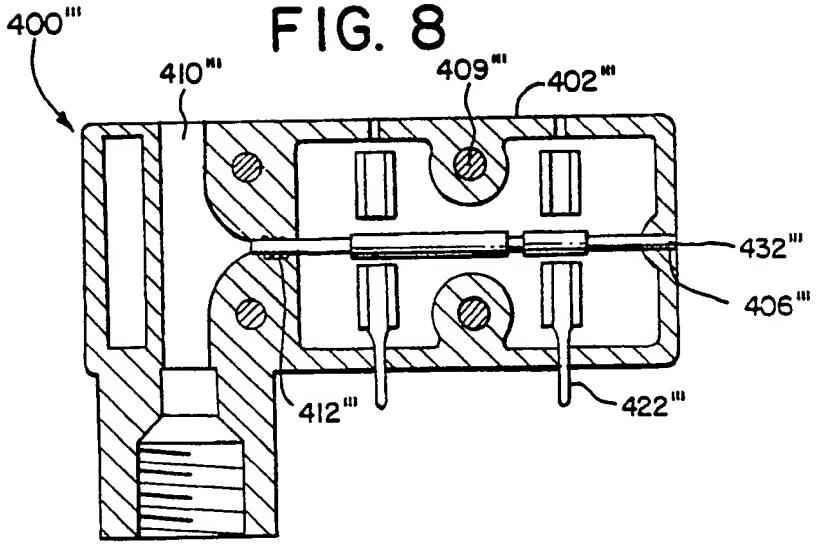


FIG. 8



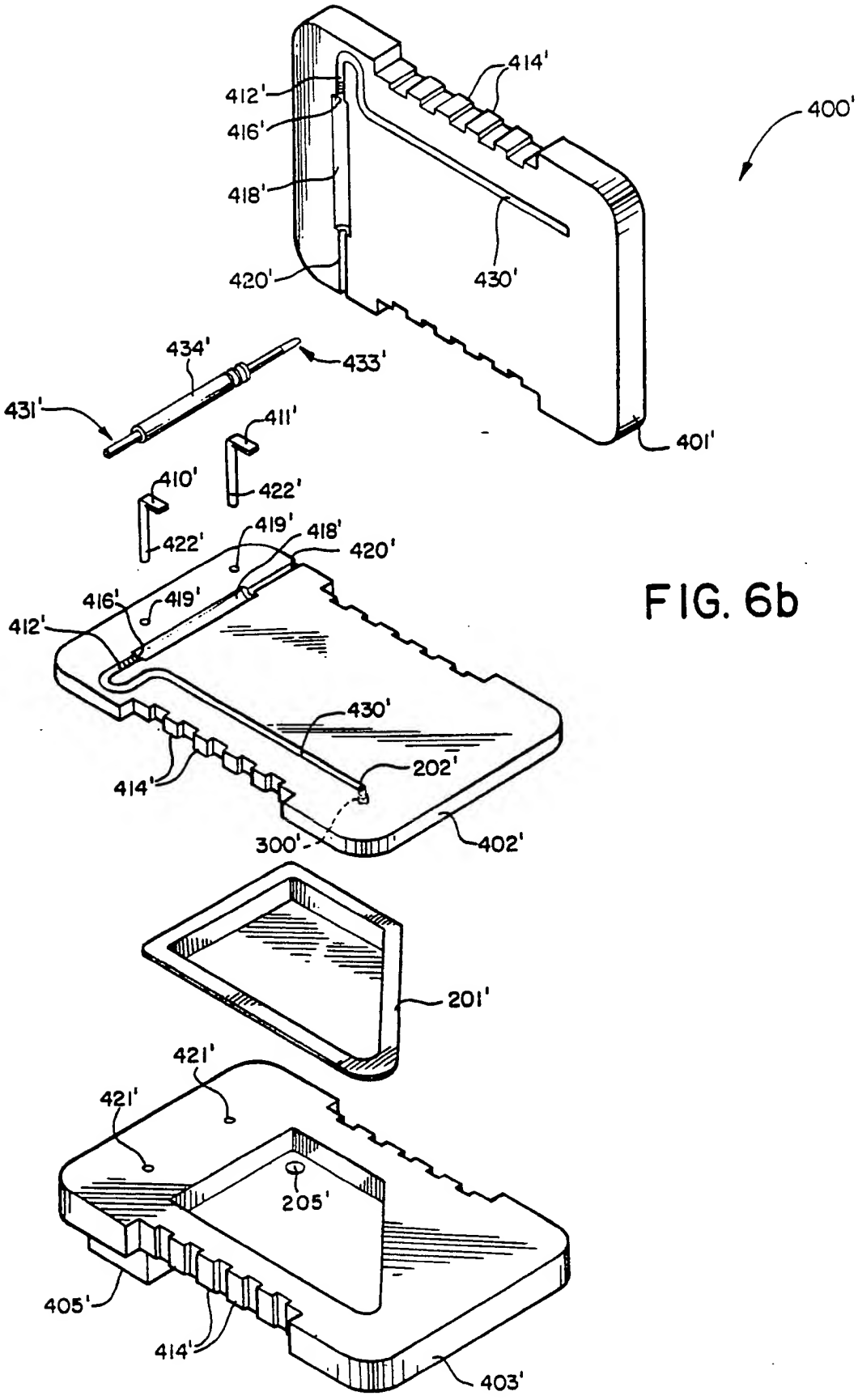

400'
414'
412'
416'
418'
420'
430'
401'
434'
433'
431'
411'
410'
422'
422'
419'
418'
420'
416'
419'
412'
430'
202'
414'
300'
402'
201'
421'
421'
205'
405'
414'
403'

FIG. 6b

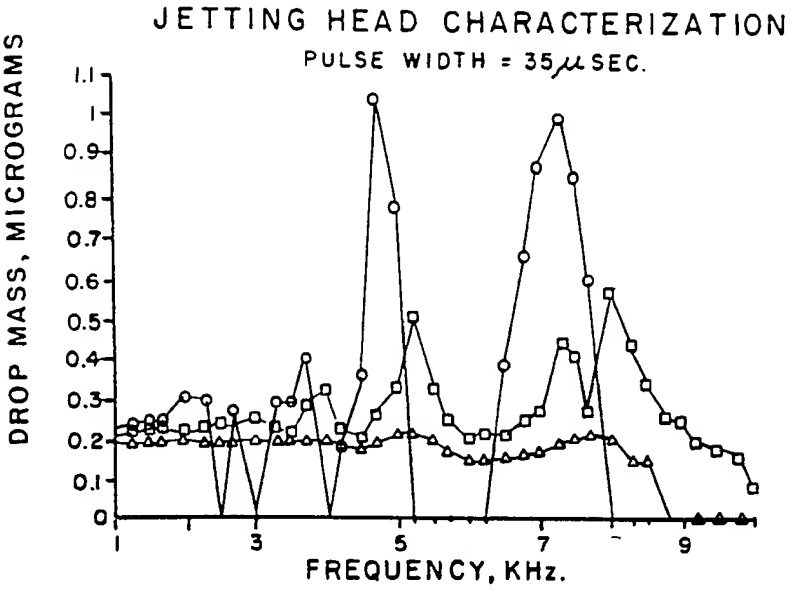


FIG. 9

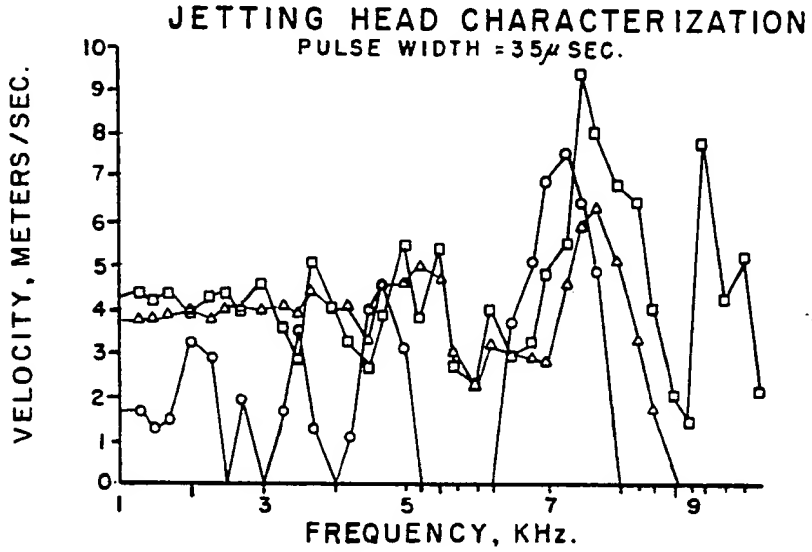


FIG. 10

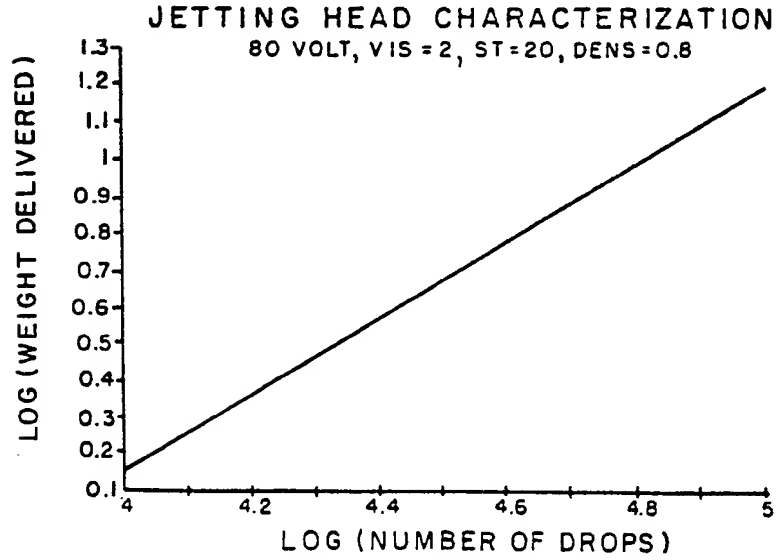


FIG. 11